Final OMP: Graduate Student Diversity Recruitment at the McDonald

Institute

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Executive Summary

The current research paper focused on the decision-making processes and recruitment activities for astroparticle physics graduate students at the Arthur B. McDonald Canadian Astroparticle Physics Research Institute (McDonald Institute). With the mandate to build astroparticle physics research capacity in Canada, difficulties in recruiting graduate students threaten to delay the science outcomes of the McDonald Institute. With the diversity of its personnel also a priority for the McDonald Institute, this research question asked: *How can the McDonald Institute develop a recruitment strategy to increase the quantity and diversity of graduate students*?

A literature review examined student decision-making models, recruitment activities, and diversity considerations to develop a research base for further exploration. Based on this literature, a mixed-methodology research plan was developed to gather both qualitative and quantitative data on the student information search and evaluation criteria, the organizational attractiveness of physics graduate programs, on-campus recruitment tactics and diversity considerations for each. The results of six hundred and forty-one student surveys from across Canada, 20 focus group participants from Queen's University physics department and five faculty interviews from the McDonald Institute were analyzed and coded to identify trends.

An analysis of the findings suggested commonalities with the literature around the importance of in-person faculty interactions, the reputation and awareness of the field, the importance of online information, the high impact of on-site recruitment through campus visits or summer schools and the need for increased financial support for students. Differences in information searches and evaluation criteria were identified in racial, ethnic, gender, and sexual minority students that suggested modified tactics were required to increase the number of diverse

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students applying. Large numbers of international students in the data indicated the link between racial and ethnic minorities were identified as largely international students who use online material as a primary source of information for their graduate school decision-making. Likewise, further literature validated data insights that large gender disparity of women in the field of physics requires human-centered narratives in the field and sensitivity towards women for improved recruitment.

A discussion of these results pointed to six recommendations that could be woven into a strategy to increase the number, quality, and diversity of graduate students recruited. Longerterm recommendations included supporting faculty with recruitment tools to focus on the inperson communication channels most impactful to graduate students, creating a strategy to rebrand astroparticle physics with a compelling narrative that more women will relate to, and introducing students to the field earlier in undergraduate school to increase awareness. Shorterterm recommendations included improving website navigation and quality of information, increasing on-site exposure activities like campus visits and summer school programs and increasing student financial support through named scholarships that promote diversity. An implementation plan was presented to address each recommendation, with resources, timing, and sequencing of steps presented to support the successful roll-out of each tactic.

Introduction

The study of astroparticle physics aims to uncover the deepest mysteries of the universe by uniting the very smallest particles to the very largest cosmic structures. This relatively new scientific field is an intersection of the fields of astrophysics, cosmology, and particle physics (Cirkel-Bartelt, 2008). Canada's contributions to the field were formally recognized with the 2015 Nobel Prize in Physics awarded to Arthur B. McDonald for his work on the Sudbury Neutrino Observatory (SNO) experiments (McDonald Institute, 2019d). The growth of this field of study in Canada has just begun and as such, the Canada First Research Excellence Fund awarded a seven-year \$63.7 million grant to form the Arthur B. McDonald Canadian Astroparticle Physics Research Institute (McDonald Institute) in 2016 and "continue their preeminence in this field" (Canada First Research Excellence Fund, 2018, para. 3).

Background

The McDonald Institute opened its doors in May 2018 as a governing body for a network of astroparticle physics researchers across Canada (McDonald Institute, 2018). To achieve their vision of becoming a centre of scientific excellence in the global community, the McDonald Institute operates under a strategy which "brings together the critical mass of scientific and technical expertise" (McDonald Institute, 2019c, para. 3). Headquartered at Queen's University in Kingston, Ontario, the McDonald Institute partners with five research institutes and eight universities across the country with strong research programs in astroparticle physics (McDonald Institute, 2019b). The McDonald Institute is led by a Board of Management who appoints both a Scientific Director overseeing the research and Managing Director overseeing the operations and staff based at Queen's University (McDonald Institute, 2019a). The McDonald Institute's main activities include the funding and support of faculty, researchers, staff, and graduate students to

advance their specialty research within astroparticle physics. A focus on creating a culture of equity, diversity, and inclusion in science is amongst the McDonald Institute's strategic goals (McDonald Institute, 2019c), which includes increasing the number of women, ethnic minorities, indigenous people, and persons living with disabilities within their personnel (Managing Director, personal communication, March 28, 2019).

Barriers to Execution

A little over a year of fully operating, many of the McDonald Institute's faculty have had trouble recruiting both the number and diversity of graduate students required to achieve their mission. The perceived issues include a diminishing pool of undergraduate students with interest in the field and challenges for faculty and departments in courting applicants into accepting an offer of enrollment (Managing Director, personal communication, February 22, 2019). This inability to recruit graduate students has created a delay in research capacity-building and decreased the anticipated scientific outputs of the research teams (Managing Director, personal communication, February 22, 2019). Management and faculty have agreed that mitigating this delay in research is a top priority and will require a tailored strategy to achieve. Additionally, a priority of management to begin building the desired equity, diversity and inclusion within the McDonald Institute, where it's hypothesized that many of the predominantly older white male faculty have an engrained culture that inadvertently promotes low-diversity recruitment, especially with women graduate students (Managing Director, personal communication, March 20, 2019). Recruitment tactics should consequently aim to increase the diversity of the graduate student population in these research departments. Therefore, this research paper asks: How can the McDonald Institute develop a recruitment strategy to increase the quantity and diversity of graduate students?

The Academic Physics Environment

Graduate student enrollment in physics has seen ebbs and flows since the 1900s (Mulvey & Nicholson, 2014) and may currently be seeing an overall enrollment decline in North America. The American Physical Society has reported a decrease in applicants to doctorate (Ph.D.) programs in physics from 2017 to 2018. This has been attributed to several possible factors including the increase in quality of competing international programs, particularly in China with large investments in their research laboratories (Mervis, 2017; Wolfe, 2018). Other factors that may influence the overall graduate student enrollment in physics have been attributed to government funding, popular physics trends in the media ten years prior to enrollment, the job market, and international policies that could influence obtaining student visas (Mulvey & Nicholson, 2014).

In addition to low enrollment, low diversity of students and faculty has historically plagued physics departments in Canada and around the world. In 2004, only 15.5% of physics Ph.D. degrees were awarded to women globally, and 12.7% of Ph.D.s awarded to U.S. permanent residents who identify as ethnic minorities. These same statistics in the comparable field of chemistry were 31.6% and 17.2% (Malcolm, Summers, & Hrabowski III, 2007), evidence that physics suffers more acutely from lower rates of diversity compared to other sciences. Although overall diversity has increased over time, the physics community continues to call for more focus on increasing women and ethnic minorities in the field, with women representing only 12.4% of physics faculty in 2010 (Xu et al., 2015). It is in this environment of low diversity and decreasing enrollment in physics that the McDonald Institute must succeed in attracting diverse, highly qualified graduate students to universities across Canada.

Report Overview

This report addresses the McDonald Institute graduate student recruitment strategy beginning with a literature review that identified themes in graduate student decision-making models, recruitment activities, and considerations for diversity recruitment. The primary research undertaken aimed to uncover trends into astroparticle physics graduate school recruitment through quantitative student surveys across Canadian physics students and qualitative student focus groups and faculty interviews at Queen's University. The surveys were quantitatively analyzed, and discussions coded to literature themes to compare gaps and overlaps, leading to a critical discussion of graduate student recruitment within the context of the McDonald Institute. Recommendations and an implementation plan were developed for the McDonald Institute based on the discussion for a successful graduate student recruitment strategy.

Literature Review

This literature review focusses on both decision-making and employee recruitment strategies that apply to graduate students while highlighting student diversity considerations of each. The decision-making literature places emphasis the phases of information search and evaluation of alternatives that students go through when choosing a graduate school or program. Both workforce and graduate student recruitment practices are discussed here, concentrating on increasing the pool of applicants through organizational attractiveness and on-site recruitment.

Models for Decision-making

To understand how students make their choices to apply or enroll in a university, it is useful to draw parallels with consumer models for buying behaviours, as universities are in the business of providing education products for students to buy (Brennan, 2001). In the model proposed by such authors as Kotler and Keller (2015), Stiber (2000), and Brennan (2001), consumers go through five stages of the purchasing process shown in Figure 1. This begins with problem recognition phase when a consumer need is triggered. In the second phase of searching for information, the consumer will actively investigate which products are available to them through a variety of sources. The evaluation of alternatives phase follows as a buyer makes judgements between different choices that fit their specific needs, weighing benefits of each before the final purchase decision is made. Kotler and Keller (2015) also argued that monitoring the post-purchase behaviour of the consumer is integral to the brand of the product, such that if they are satisfied, they will re-purchase and promote the product through word-of-mouth.



Figure 1: The five stages of the buyer decision-making process, adapted from Kotler and Keller (2015, p. 100).

This consumer buying process model has been adapted for the university market to describe both undergraduate and graduate school application and enrolment behaviours of students. The problem recognition phase was described by Stiber (2000) and Perna (2004) as a student recognizing they want to continue their education, instead of joining the workforce. In the undergraduate context, Brennan (2001) argued for a phase before problem recognition that included decision-making capability and the motivation to begin a search in which "the student must believe that they are capable of solving the problem (...) and must be motivated to search for appropriate information" (p. 85). The phases of information search and evaluation of alternatives are the main drivers for the majority of academic research in student decision-making, as these phases produce the most useable management insights that can be used as targeted recruitment tactics (Dawes & Brown, 2002; Poock & Love, 2001; Stiber, 2000).

Information search. Understanding the information search phase of prospective graduate students allows universities to focus on marketing and recruitment information in the channels that students find the most influential. In this phase, the student will start with an awareness set of all products known to them, and then narrow down their options to the consideration set which meets their needs and then finally the choice set for which a consumer actively gathers more information (Dawes & Brown, 2002; Kotler & Keller, 2015; Shocker, Ben-Akiva, Boccara, & Nedungadi, 1991). The consideration and choice set can include information

from personal sources such as current students, alumni, friends, family, colleagues, and the student's personal experiences with the university or campus. Non-personal, commercially marketed material is also included in the possible sources of information such as brochures, catalogs, advertisements, websites, conference booths, and informational meetings. The relative importance of these sources of information, however, is not agreed upon in the literature. Brennan (2001) found that the information used most was non-promotional general information provided by the institutions, with the next most important being personal information received by students, and the least influential being promotional material and campus visits. Poock and Love (2001) agreed with the finding that personal sources of information, specifically from faculty members were influential on student choice over promotional sources of information and suggested that campus visits were a highly influential source of information, particularly in racial and ethnic minority students. Also in disagreement was Dawes and Brown (2002) who found that commercial marketing methods had the most influence over student choice in the information search phase for prospective business students, in which brochures and on-campus tours ranked as most influential by administrators and students alike.

Evaluation of alternatives. Once the information search has begun, the consumer decision-making model indicates that the student moves to the evaluation of alternatives phase, weighing the options of different schools and programs based on their personal needs. In a literature review of multiple graduate student choice studies, Lei and Chuang (2010) found broad categories of evaluation criteria in common for all prospective graduate students: institutional, departmental, program, faculty, and personal factors. The ranking and importance of each factor do not agree within the literature but generally show that academic reputation, financial considerations, social life on campus, considerations around a spouse's situation, and whether

the program leads to securing a job after graduation are included in the top factors in graduate student choice (Brennan, 2001; Kallio, 1995; Poock & Love, 2001; Stiber, 2000). Brennan (2001) provided an overview of these undergraduate criteria that universities can manage and therefore market, adapted in **Error! Reference source not found.**.



Figure 2: Criteria for evaluating undergraduate universities, adapted from Brennan (2001, p. 56).

To understand the impact of these criteria in the decision-making process, surveys and questionnaires in multiple studies provided a ranked list of important factors for various graduate student populations. Stiber (2000) found in a study with prospective U.S. business students that the highest-rated criteria used in evaluating the school were quality of faculty, relevant

curriculum, respected school accreditation, responsive faculty and respected school reputation, each of which is a factor related to the product in *Figure 2*: Criteria for evaluating undergraduate universities, adapted from Brennan (2001, p. 56).**Error! Reference source not found.** Brennan (2001) found in Australian undergraduate students that the top five criteria by importance were the degree program offered, the location of study, the relevance of the program to the student's aspirations and image or reputation of the school and the perceived job-related outcomes. Similar academic factors were found to have importance to students by Poock and Love (2001) for doctoral students in higher education administration. In an older study of graduate students that laid the groundwork for further studies into graduate student choice, Kallio (1995) found that social factors were not as important to prospective graduate students as undergraduates; however, accommodating a spouse's career plans in the decision-making was a major factor given the older life stage of graduate students than their undergraduate counterparts. These results agreed with Poock and Love (2001) who found that older students considered more family-related factors than their younger counterparts.

Recruitment Activities

Parallel and intertwined with marketing efforts, recruitment has been described as the process and methods used for the psychological persuasion of a candidate to form a positive impression of working with an organization (Breaugh, 2013, p. 392). Workplace recruitment, therefore, shares many characteristics with university marketing and recruitment of prospective students, all of which use tactics to persuade a candidate to apply and ultimately accept an offer. The decision-making for the applicant includes a complex search for information and a high-stakes choice to be made (Breaugh, 2013; Stiber, 2000). Other similarities included the role that the reputation of the organization or university has on a candidate's intentional to apply

(Breaugh, 2013; Brennan, 2001; Stiber, 2000). Likewise, the work environment, location, and culture played similar roles in a candidate's decision-making process whether they were a prospective graduate student or a job-seeker (Chapman, Uggerslev, Carroll, Piasentin, & Jones, 2005; Griffin & Muñiz, 2011). The literature review that follows includes the recruitment-specific activities that influence the decision-making process within the recruitment contexts of workplace and university environments.

Organization and job attractiveness. An attractive brand and reputation of an organization have been found to be one of the most significant factors influencing a potential applicant's decision to apply for a job (Allen, Mahto, & Otondo, 2007; Breaugh, 2013; Rynes, Bretz, & Gerhart, 1991). Managing these factors in an organization has been found to increase the applicant job pool from which the recruitment process begins. This initial perception of an organization was particularly important, as it was often formed peripherally with a candidate's prior information about an organization, and once it had been formed, is difficult to change (Allen et al., 2007; Breaugh, 2013). Rynes et al. (1991) found that press coverage of the organization was a significant factor in influencing prospective applicants' views, even before they began their information search. Likewise, in a study of business student job-seekers, Cable and Turban (2003) found that reputation was used to infer the specific job attributes and attractiveness, and that reputation created pride in membership of that organization. Brand-equity activities for organizations can, therefore, serve as recruitment tools and increase the applicant pool (Bock et al., 2014; Cable & Turban, 2003).

As an important tool in an organization's brand, the website can be used to provide organizational and job information that increases the attractiveness of a job for a potential candidate. In a study of undergraduate and graduate students searching through real-life

organizational websites, Allen et al. (2007) concluded that "the website may play a more significant role in shaping the image of the organization than an individual recruiter" (p. 1705). With the opportunity to provide richer mediums of communication, recruitment materials should include videos, employee testimonials, showcasing awards, stating organizational policies and including photos of employees to communicate culture and credibility (Breaugh, 2013; Walker, Feild, Bernerth, & Becton, 2012).

Likewise, the amount and quality of information about a job opening or about the organization can help or hinder the recruitment process. Breaugh (2013) argued that the cognitive processes used in processing job information are considerable and complex and that a person is more willing to compute extra information if they are actively seeking a job. Candidates may, therefore, be less likely to apply to a position for which they have little or uncertain information (Allen et al., 2007; Breaugh, 2013). Although these studies suggest that more information is generally better for recruitment purposes, the content of the messaging must be considered in recruiting for a diversity of candidates.

Recruiter characteristics. The personal contact between recruiter and applicant have been found to be a persuasive and important part of forming positive or negative perceptions of an organization during the recruitment process. Chapman et al. (2005) found that an applicant's intentions to pursue a job were related to how personable the recruiter was. Additionally, the study found that perceived qualities of competence, informativeness, and trustworthiness were influential in the acceptance intentions of a candidate. Poock and Love (2001) found that "students are not swayed by their interaction with faculty; they are swayed by positive interactions with friendly faculty. Thus, a positive, friendly attitude is essential" (p. 217). This interaction has been found to be so important that in the higher education context, studies have recommended that interactions with faculty instead of students or staff recruiters produce a higher yield of applicants (Griffin & Muñiz, 2011; Poock & Love, 2001; Wieman, 2011).

On-campus recruitment. A job site visit is a tool highly accepted in job recruitment as an opportunity to maintain and sway an applicant's interest. These visits can be performed before, during or after the interview process and provide an opportunity for the candidate to get first-hand information about the job, visit the location, meet prospective co-workers, see the diversity of employees, and meet with a potential supervisor (Boswell, Roehling, LePine, & Moynihan, 2003; Breaugh, 2013). In particular, Rynes, Bretz, and Gerhart (1991) and Boswell et al. (2003) both found that during the visit, meeting with other employees in a similar position, meeting with a similar demographic of people and meeting with higher-ups in the organization all have a positive effect on the job-choice. Chapman et al. (2005) also found through a metadata analysis of 71 studies that interactions with perceived higher-up employees during the recruitment process led to higher intentions to accept a job offer. Likewise, negative behaviours during site visits could dissuade an employee from accepting a final job offer, including disorganization, uninformed recruiters, arrogance, condescension or perceived lack of interest in a candidate (Boswell et al., 2003).

On-campus recruitment activities offer similar benefits to job site visits for student recruitment. Campus tours organized by the school can offer students the opportunity to receive first-hand information from faculty, potential supervisors, other students enrolled and see campus life and culture for themselves. Poock and Love (2001) recommended that program coordinators make efforts to arrange campus visits for students as best practice for graduate student recruitment, and ensure that the visit is positive, friendly and organized. Similarly, Griffin and Muñiz (2011) suggested that campus visitation programs provide graduate student

recruiters a successful tool by connecting prospective students to the campus, faculty and current students either before or after they apply to the program. This disagreed with the result from Brennan (2001) who found campus visits as the least influential source of information for potential graduate students; however, other studies found this tool especially important for recruiting students of underrepresented backgrounds. Griffin and Muñiz (2011) suggested that Black and Hispanic student application yields increased with campus visitations where they were able to connect with students of similar backgrounds, see life on campus first-hand and create trusted connections with faculty. In particular, on-site summer research programs that bring undergraduate students on campus to experience research, campus life and get to know faculty was shown to be an excellent tool for recruitment, especially for students without access to research in their undergraduate degrees (Griffin & Muñiz, 2011; Poock, 2007).

Finally, there are mixed recommendations in the literature around recruitment through off-campus graduate student fairs and academic conferences. In a study interviewing graduate diversity recruitment officers at research universities in the United States, many see off-campus graduate school fairs as costly, providing only surface-level interactions with students that do not achieve their enrolment goals (Poock, 2007). Contrarily, in one case a recruiter described seeing a 25% increase in underrepresented students in the department when faculty, instead of recruiting staff, were present at the graduate conferences (Griffin & Muñiz, 2011). The recommendation that more faculty participate in recruiting at conferences and graduate fairs is echoed by Poock (2007) and by one physics faculty member advocating that all physics department faculty should spend more time recruiting graduate students for the good of the field as a whole (Wieman, 2011).

Diversity Considerations

Diversity considerations in decision-making. Studies have found differences in information sources and evaluation criteria when race and gender are factored into the student population. Poock and Love (2001) suggested that very few differences between male and female students exist in student choice; however, the rigor of the program and academic accreditations were more important considerations for females. They also found that racial minorities place more importance on non-academic factors such as sensitivities to minority groups, affordable housing, campus visits, student services and friends living in the area. Likewise, Griffin and Muñiz (2011) suggested that summer research programs, campus visitation programs, and information from faculty from historically Black colleges and universities promoting graduate programs are more effective for students of colour in the United States. Offering financial compensation in the form of assistantships to underrepresented groups was found by Poock (2007) to be the most effective recruitment tool for graduate students.

Diversity considerations in recruitment activities. Diversity cues in recruitment images, websites and messaging have been shown to have positive effects on attracting a diverse applicant pool to a position. The effect known as similarity-attraction is a well-studied social phenomenon where individuals are more attracted to people who exhibit similar demographics, attitudes or personalities (Perkins, Thomas, & Taylor, 2000). This phenomenon has recently been extended to the context of the employer-employee attractiveness of potential candidates (Devendorf & Highhouse, 2008). Many studies of student recruitment have suggested that attracting a diverse pool of applicants can be supported by training diverse recruiters (Griffin & Muñiz, 2011; Newman & Lyon, 2009; Poock & Love, 2001). This is contrary to the workplace

findings that the ethnicity, age or sex of the recruiter had no effect on the applicant's attraction to the position (Breaugh, 2013; Chapman et al., 2005).

Presenting diversity images in recruitment brochures to enhance the similarity-attraction via demographic representation was shown by Avery, Hernandez, and Hebl (2004) and Perkins et al. (2000) to have a positive effect on the attitudes of Black and Hispanic applicants towards an organization, greater than for White participants in the same studies. The people depicted by the materials did not need to be of an identical race to attract an applicant; however, an overall depiction of diversity was more important to minority applicants (Avery et al., 2004). In a more recent study by Walker et al. (2012), they found that presenting photos of diverse employees and stating the diversity goals of the organization on the website were more likely to contribute to thorough processing of information by all applicants, regardless of race or gender.

Literature Review Summary

The literature on decision-making models for graduate student choice concentrates on the information search and evaluation of alternatives phases. Studies disagreed with the exact top factors in each, including a conflicted conclusion on whether personal or commercial sources of information were the most impactful for the information search in recruitment. Likewise, the importance of evaluation criteria differed between studies with some overlap in the importance around faculty, academic product, reputation, and relevant degree program within multiple studies, as well as increased importance on social factors for older graduate students.

Recruitment literature provided a deeper insight into the similarities between workforce and graduate school recruitment. The attractiveness of an organization was considered an important aspect of increasing the applicant pool and can be influenced by online information

and reputation. Face-to-face contact with candidates in the application process was shown to have the most influence on an applicant's final decision to accept or reject an offer. Friendly recruiters, timeliness in recruitment processes, on-site visits and summer research programs were found to improve recruitment effectiveness. There are mixed results found with recruitment graduate student fairs and conferences; however, faculty instead of students were found to be better recruiters when these activities were performed.

When considering differences in minority student populations, some differences were found in recruitment tactics. Literature suggested that racial minorities placed more importance on non-academic criteria, in-person contact, financial considerations, and admissions processes. The similarity-attraction phenomenon was found to be important in recruiting materials and interactions with faculty and students of the same race, ethnicity or gender identity were found to play a role in diversity recruitment on campus. There is no consensus in the literature on whether recruiter racial, ethnic or gender identity plays a significant role in the recruitment of minorities.

There are gaps in the present literature, with very little of the decision-making and recruitment strategies based in a Canadian university context. Likewise, none of the literature studies explored science-related fields of research in which gender and ethnic disparity have been found to play a unique role (Malcolm et al., 2007). The diversity implications in the literature are likewise limited and focus mainly on Black and Hispanic minority students and women, with no information presented for transgender, non-binary or genderqueer students. No information is likewise presented for students of diverse sexual identity, leaving a significant gap in understanding decision-making and recruitment activities for these students.

Research Methodology

The research methodology used to answer this research question was a mixed methodology of qualitative and quantitative data to gain insights into a recruitment strategy for diverse graduate students. The quantitative survey method provides a large number of responses to assess student demographics and characteristics, also providing a statistical analysis from a larger data set (Oak Ridge Institute for Science and Education, n.d.; Rhodes, 2013). This quantitative method was ideal given the previously designed surveys which answer similar questions in the literature studies (Brennan, 2001; Kallio, 1995; Poock & Love, 2001; Stiber, 2000).

The qualitative aspects of the methodology were collected through student focus groups and primary interviews with faculty which provided more complex information to be gathered and insights to be surfaced from participants (Krishnaswami & Satyaprasad, 2010). It is required to understand the 'how' and 'why' research around student choice of a graduate program, including emotional responses, which was collected through the guided open-ended discussions of the focus groups and interviews (Krishnaswami & Satyaprasad, 2010; Western Australian Centre for Health Promotion Research, 2010). Likewise, the qualitative methods allowed for deeper probing into topics that were not previously known and allowed participants to focus on points they felt were important within the context of the interview or focus group. Together the quantitative and qualitative data provided a more complete understanding of how best to construct a recruitment strategy that promotes diversity in graduate students.

Student Survey Questionnaires

The survey tool used was a mixed-method questionnaire providing quantitative data for a large number of students with statistical analysis of multiple-choice questions and

categorizations of open-ended questions (Oak Ridge Institute for Science and Education, n.d.). Two versions of the online questionnaire were created in Google Forms. One version was sent to 880 graduate physics students and another to 1839 undergraduate physics students, through the departmental mailing list of the Canadian Association of Physicists (CAP) as well as the physics department mailing lists in Table 1, with the support of the McDonald Institute and the CAP. The McDonald Institute and Queen's University faculty also send the graduate student survey to approximately 20 students, however exact numbers are unknown. All survey links were active for seven days in October 2019, over which time 218 graduate and 423 undergraduate survey responses were collected.

Mailing Lists	Undergraduate	Graduate
САР	438	271
McMaster University	179	69
Acadia University	25	0
Dalhousie University	60	61
Université de Sherbrooke	80	60
University of British Columbia	350	188
Ontario Tech University	45	0
Université de Laval	290	133
University of Guelph	200	62
Concordia University	145	35
University of Prince Edward Island	27	1
McDonald Institute & Queen's University	unknown	unknown
Total emails sent	1839	880

Table 1: Number of physics students receiving survey links.

To mitigate a low response-rate and sampling bias that would include only engaged students as survey respondents (Peters, n.d.; Trochim, 2006), the surveys were sent out on behalf of the McDonald Institute and endorsed by the CAP with a monetary incentive to be entered to win a \$50 gift certificate upon survey completion. Questions are presented in Appendix A, formulated to understand student demographics, their sources of information for graduate school

decision-making and the evaluation criteria they feel is most important in choosing a school. General awareness questions were also included to evaluate the field of astroparticle physics. The five-point Likert scale ratings were adapted from Stiber (2000) while the list of information and criteria were chosen from studies of Stiber (2000), Kallio (1995), Poock and Love (2001) and Brennan (2001), and adapted to the Canadian physics context to ensure that criteria were exhaustive. Diversity and demographic questions were adapted from previous surveys provided by the McDonald Institute and Queen's University to match their standards.

The data analysis conducted on the survey responses focused on calculating the average Likert score out of five for each source of information and evaluation criteria for various cross-sections of students. Data in tables presented in Appendix B are colour-coded from a five in green five on the Likert scale to a one in red, to visually represent the calculated averages. The main analysis included only information from students in third year and over to segment those students closer to the graduate school decision-making phase or currently in graduate school. To understand whether two student segments answered the survey questions differently, a Student's independent, two-sample t-test was performed on any two data sets in question with the assumption that they are different sizes with equal variance. The 95% confidence level was chosen for an alpha of 0.05 to assess the statistical significance of results between student survey responses.

Student Focus Groups

Three student focus groups were performed to gather open-ended qualitative information through a structured set of questions. Recruitment of students was done through a list of 69 graduate students provided by the McDonald Institute and through the Queen's Physics departmental email list of approximately 100 third- and fourth-year undergraduate physics and engineering physics majors, with free pizza lunch as an incentive. The resulting focus groups consisted of one group of six undergraduates, one group of seven master's (MSc) students and one group of seven doctorate (Ph.D.) students. Of the 14 graduate students, seven were affiliated with astroparticle physics research groups at Queen's, the others from other physics fields. Timing of the focus groups was set for the third week of the fall semester, allowing for a fresh graduate school decision for any graduate students in their first year of master's or doctorate programs, a method also used by Dawes and Brown (2002).

The focus group consisted of a pre-interview questionnaire to evaluate diversity information, a series of discussion questions and a handout questionnaire identical to the student survey. Questions can be found in Appendix A for both undergraduate and graduate student focus groups. The questions were inspired by the previous survey study of Stiber (2000) to understand the information search and evaluation of alternatives phases of the decision-making process, as well as questions specific to graduate student recruitment and diversity at the McDonald Institute. By replicating the survey questions, the data analysis for the focus group was able to compare insights to the larger student surveys while probing deeper into the reasoning within the decision-making process with individual students.

The focus groups were audio-recorded and later transcribed. The transcripts were then coded into themes that arose from the student discussions and literature: problem recognition, information search, evaluation of alternatives, reputation, website, diversity recruitment, recruitment processes, recruiter characteristics, recruitment methods, and student recommendations. The summary of the focus groups and coded findings can be found in Appendix C. Student names have been replaced by participant numbers to maintain anonymity.

Faculty Interviews

Individual interviews with five faculty from the Queen's University Physics Department were conducted to learn about current student recruitment and diversity practices exploring both barriers and opportunities. Three of the faculty were astroparticle physics researchers supported by the McDonald Institute. Questions included in the interview guide (found in Appendix A) were partially adapted from studies conducted with university administrators on the topic of graduate student recruitment of Poock (2007) and Griffin and Muñiz (2011). Interviews were approximately 60 minutes in length, with four in-person interviews and one web conference interview. Audio was recorded from all in-person interviews and hand-written notes taken during the web conference.

The qualitative analysis was conducted through a note-taking process of the audio recordings after the interviews to pull out commonalities and disconnects. As themes emerged through the data analysis, the notes taken were grouped into headings: evaluation alternatives and information search, reputation, recruitment methods, diversity, financial and opportunities. A summary of all faculty interviews is found in Appendix D with these themes, names removed to maintain anonymity.

The data across the three sources of information were analyzed in parallel based on the literature themes that emerged in decision-making models, recruitment activities and diversity considerations for each. The findings highlight cases in which surveys, focus groups, and interviews contained contradictory information, and those in which they agreed. Opportunities and suggestions for recruitment tactics from faculty and students are included only where relevant to this report, a full listing is included in Appendices C and D.

Limitations

The limitations of the research methodology are considered in the data analysis. This includes the limitation of student focus groups and faculty interviews which were limited to the Queen's University Physics Department. Therefore, some data may be skewed towards the particulars of the department and not representative of all McDonald Institute affiliate universities. Likewise, limitations of the student surveys conducted across Canada include some low number statistics when students were divided into gender, race, ethnicity, and sexuality such that the statistical significance of the findings across groups was not always possible. Lastly, the student survey did not ask whether students had domestic or international student status, limiting the certainty in the analysis and discussion of these results.

Findings

Models for Decision-making

Student survey and focus groups suggested that most students in undergraduate degrees have considered graduate school after graduation. When asked "Have you considered applying for graduate school after graduation?", 93% of undergraduate students replied yes. Of the 29 who answered no, 18 provided reasons why with just less than half of whom indicated that it is not required for their intended career path. These results are categorized by academic major in Appendix B (Table B6 andTable *B7*).

Information search. The student survey data provided insights into the information search phase of students' decision-making by asking current graduate students to rate the importance they placed in the information sources from any institution or program they considered in their graduate school decision. The results for average scores are presented in Appendix B, Table B8 for master's and doctorate students. The data shows that personal communications were the most influential source of information in student choice, including information from faculty within the department and information from another graduate student. Altogether four of the top five scoring information sources were found to be first-hand, personal information. The focus groups agreed with this finding, where thirteen of twenty students indicated that personal contact with a faculty in the department was important or very important with equal numbers who indicated personal contact with a current graduate student in the department was important. Likewise, faculty interviews indicated that they often relied on having conversations with students before they applied to provide more information and support their application process. The least important sources of information included the more overtly promotional and commercial sources. These included promotions or advertisements, university and departmental brochures, and graduate student fairs whose intended purpose is to draw students to the department or program. Focus group students noted that they felt information from brochures may be biased, whereas other sources of information such as conversations with current graduate students would be more truthful. The only commercial information source in the top five was the departmental website, discussed further in subsequent sections.

Evaluation of alternatives. Student surveys indicated that physics students' top five criteria for evaluation were the specific field of study, research opportunities, quality of the research facilities, tuition and cost, and reputation of the department's faculty. The full rankings are found in Appendix B Table B9. Least important factors across all years of study were those relating to a student's personal life such as child care and spousal considerations, as well as sensitivity to diversity issues.

Evaluation Criteria	3 rd year +	MSc	Ph.D.	Total
Quality of teaching	4.5	4.1	3.7	4.1
Geographic location	3.9	4.3	4.2	4.1
Institution's academic reputation	4.0	4.3	4.0	4.1
Amount of stipend provided	3.7	4.3	4.2	4.0
Program structure and requirements	4.0	3.9	3.5	3.8
Post-graduate job placement	4.0	3.6	3.4	3.7
Total Student Count	177	95	122	395

Table 2: Differences in individual evaluation criteria averages between undergraduate and graduate students which are shown to be statistically significant (in bold) compared to all students in third year and above.

Findings indicated statistically significant differences in evaluation criteria between upper-undergraduate (third year and above), master's, and doctorate students. Table 2 shows averaged individual criterion scores for each group of students, with statistically significant scores indicated in bold when compared to the total. Upper undergraduate students were found to place more importance in the quality of teaching and post-graduate job placement. The value placed in these two factors is found to decrease steadily from first-year undergraduate until the doctorate level as students progress in their programs. This agrees with the focus groups in which undergraduate students were still considering whether they would attend graduate school or go into industry jobs. Master's students placed a higher value in the amount of stipend provided when compared to undergraduate and doctorate students and higher importance in the availability of financial aid when compared to doctorate students. The importance of financial support appeared only once in the student focus groups, with one student who noted "As a grad student you're like going into your thirties not being able to save up. It affects you, because you see your friends making a lot of money and just being financially secure".

Agreeing with the importance of the financial support seen in the student surveys are findings in faculty interviews which showed concern for lack of student funding. One faculty noted the McDonald Institute covers the faculty or researcher's cost of hiring a graduate student of approximately \$9,000 to \$10,000 for a domestic student, with the positive outcome of significantly reducing the financial burden from the faculty. However, the student salary was still perceived as low, as one faculty indicated that a student rejected their offer for a higher-paying \$90,000 salary from an American school, even though the American school's take-home salary was likely lower due to costs of living and tuition. International students may be at a disadvantage, as one faculty noted the cost to hire them almost doubles when compared to a

domestic student, and another faculty agreed that international students are harder to recruit as there was less funding available for them from the university. Two faculty both suggested that an international scholarship from the McDonald Institute may increase the appeal to international students in applying, one faculty noting that they are currently paid less than their domestic counterparts with similar academic standings.

Recruitment Activities

Organization and job attractiveness. The extent of the awareness, reputation, and online presence are investigated as factors that can affect organization and job attractiveness. These were explored through the surveys, focus groups and interviews to understand the awareness and reputation of astroparticle physics with students. Websites for the McDonald Institute, Queen's University, and astroparticle research groups were considered in the focus group results and overall use of websites from student surveys.

Familiarity with the field of particle astrophysics. Student surveys, focus groups, and faculty interviews indicated undergraduate students are not generally aware of the field of particle astrophysics. In the undergraduate student survey, only 33% of students overall and 40% of students in third year and above were aware of the field of astroparticle physics. Individual responses per undergraduate year are shown in Table 3, with similar trends for each year.

Undergraduate Year	No	Yes	Unsure	Student Total
1st year undergraduate	64%	24%	11%	107
2nd year undergraduate	59%	30%	11%	122
3rd year undergraduate	60%	37%	2%	86
4th year undergraduate	44%	51%	5%	55
5th+ year undergraduate	74%	22%	4%	23
Total Percentage	60%	33%	8%	100%

Total Count 234 128 31 393

Table 3: Percentage of undergraduate students indicating a familiarity with the field of astroparticle physics.

The results for the open-ended follow-up question asking how they had heard about the field indicated most awareness is from informal means of attending guest lectures, personal interests and media such as podcasts, TV shows like the Big Bang theory or Cosmos or media figures like Neil deGrasse Tyson and YouTube videos. Categorized results are found in Figure 3 that illustrates only 15% of students had been introduced to the field their undergraduate courses and 7% through the Canadian Astroparticle Physics Summer School (CAPSS) presented by the McDonald Institute.



Figure 3: Categorized undergraduate student survey responses to the question "How did you hear about astroparticle physics".

The lack of awareness of the field provided by undergraduate physics courses was echoed by one faculty who described a successful attempt to update an undergraduate course to include particle physics one semester earlier in the undergraduate curriculum to create earlier exposure to the field. Two students in the undergraduate focus group echoed this lack of information available to them when making their decision. One student commented on how with all of the different branches of physics, it is difficult to know whether they will like the field of astroparticle physics.

For the students who were aware of astroparticle physics, findings indicate they may not be getting a compelling story that persuades them to pursue it in graduate school. One undergraduate focus group student perceived the field negatively as "data-heavy" and another had the impression that there was more just cleaning and maintaining of experiments. One faculty indicated they didn't think the full story of how exciting the field is was getting through to the students, while another surmised that articles such as "The 'WIMP Miracle' Hope For Dark Matter Is Dead" may have introduced the reputation for inactivity in the field (Siegel & Starts With a Bang, 2019). None of the faculty in the interviews believed this reputation of the field to be accurate, but three agreed that a better job should be done of selling the true excitement of the field.

Reputation of Queen's and the McDonald Institute. The reputation of the faculty and university were important for students considering and attending graduate school. Student surveys indicated these two factors ranked in the top ten considerations, including the value of a degree from the school in Appendix B, Table B9. Focus group conversations with current Queen's graduate students indicated that the reputation of the Queen's physics research program was neutral with little good or bad to be said about it, especially on an international level. Many agreed that in their experience of the quality of research in the department, the reputation should be higher. One student said, "It's not so much that it doesn't have a good reputation, it's just there's no reputation at all".

Website. Departmental websites were found to be influential sources of information for graduate student searches, with master's and doctorate students ranking it third most important overall with an average of 3.9 and 3.8 respectively, shown in Table B8. Student focus groups indicated that they use the faculty member's webpage to contact them before they apply, which is where faculty agreed that most information about potential graduate research lies; however, the websites lack content and students often require direct email contact with the faculty to understand the job opportunity. One Ph.D. student said, "Usually the younger faculty had their own website with much more detail, it was definitely a strong factor in favor of them because I could actually without talking to them and sounding like an idiot, I could get an idea of what they're doing".

The websites for Queen's University Physics, Engineering Physics and Astronomy and Queen's Particle Astrophysics were found to hurt students' perceptions. All students in the focus groups indicated that they were disappointed with the lack of information and older aesthetic in agreement with two faculty on the subject. Additionally, quality and currency of information was lacking on the Queen's Particle Astrophysics website in Figure 4 shows an older design aesthetic, broken links, outdated position postings from 2018 (circled for clarity in red), and outdated faculty and student lists further into the website (Queen's Particle Astrophysics, n.d.).



Figure 4: The Queen's Particle Astrophysics website from November 10, 2019. Outdated information is circled in red (Queen's Particle Astrophysics, n.d.).

Recruiter Characteristics. Interactions with faculty and students from within the department of interest are the top sources of information for potential graduate students. Student surveys of 217 master's and doctorate students that these sources of information are the top two most important when choosing their program. This result holds across all demographics for the sample surveyed of identified gender, identified racial and sexual minorities, and identified disability to a high statistical significance. Student focus groups also indicated that conversations held with potential supervisors via email, Skype or phone were important to their decision to attend their current graduate program. Ten of the 14 graduate students in the focus groups mentioned specifically a faculty interaction that was part of their decision made to choose their current department. The student surveys likewise placed information from previous
undergraduate program faculty and first-hand information obtained through the interview process in the top five information sources for master's and doctorate students.

The friendliness of faculty was also an important factor for students in choosing their program. In the student surveys, the friendliness of the department staff and faculty was rated an average of 4.0 across all students. Student focus groups emphasized friendliness as a deciding factor, with two students indicating it was the friendliness that sold them on the position.

On-campus recruitment. Findings indicated that summer research programs and internship opportunities are important decision-drivers; however, most students do not attend them. Two of the focus group master's students had been part of the summer school with CAPSS presented by the McDonald Institute and another worked at SNOLAB in Sudbury through their undergraduate co-op placement from the University of Waterloo. All three noted their experiences were impactful and were the reason they chose to go to Queen's and into the field of astroparticle physics. Contrarily, the surveys found summer research programs to be a lackluster source of information with an average of 3.4 for master's students and 2.8 for doctorate students. Diving deeper into the individual responses for this question, Figure 5 indicates that scores were skewed lower by a large number of students who indicated it was "not a factor" in their decisionmaking, likely not having attended. 103 students indicated this was an important (four) or very important (five) factor in their choice, showing its importance for those who attended. Student surveys also found that six of 91 undergraduate students learned about the field of particle astrophysics from the CAPSS program and another four from working on particle astrophysics research during their undergraduate programs. Faculty interviews indicated that the number of graduate students produced from the CAPSS may not be recorded; however, it was the original

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intention of the program to do so and measure the success of this graduate student recruitment tool.

Figure 5: Breakdown of graduate student survey Likert scores for the importance of a summer research program within their graduate department as a source of information.

Findings indicated that campus visits have mixed results as a recruitment tool and may not be often provided to students or are not well organized. One faculty indicated that campus visits to introduce a potential student to exciting research and team activities, which were crucial aspects of their successful recruitment strategy. Another faculty member commented that an awkward visit from a student may have contributed to them not accepting an offer. Student survey averages found this to be a mediocre source of information, with an average score of 3.1; however, another dive into the data in Figure 6 reveals a large spread in responses with 58 students likely not having experienced a tour at all.



Figure 6: Breakdown of graduate student survey Likert scores for the importance of campus visits or tours as a source of information.

Diversity Considerations

Within the results of the survey and focus groups, demographic data were used to present the results of decision-making and recruitment activities with attention to the diversity of students. Findings relating to race or ethnicity, gender and sexuality are presented, highlighting the statistically significant differences between Likert scores. Comments from student focus groups were likewise used to add a deeper qualitative understanding of the survey results.

Diversity in decision-making. Findings suggest that differences in the importance of information sources and evaluation criteria existed between gender, race, and sexuality. The sources of information and evaluation criteria, when divided into minority and majority segments in these populations, are presented in Appendix B *Table B10, Table B11, Table B12.* Students who identified as racial minorities placed statistically significant importance on information from online sources such as departmental and university websites and online communities, as well as attending a summer research program. Although international student status was not specifically

asked in the survey, the faculty suggested that many visible minority students in the department were international students. One international student identified the focus group said the only source of information available to them in their country was the Queen's departmental website before contacting their supervisor directly. This information indicates that international students rely more heavily on website information than domestic students.

The importance placed on social and diversity considerations were much higher in gender and sexual minority students. To highlight these differences in the data, Table 4 shows three diversity considerations with statistically significant differences in average scores when compared to their majority counterparts. Likewise, the student focus group conversations around diversity showed concern for increasing equality of gender in the field of physics. Two students commented that larger cities are better places for students to find diversity and that it had or would factor into their decision for graduate school. One student commented "I'm tired of all my professors being white men", and that diversity survey information from universities was an important source of information for their search.

				Sexual M	linority
	Ge	nder Iden	Identifi	cation	
			Trans-gender,		
Evaluation Criteria	Male	Female	non-binary, genderqueer	No	Yes
Sensitivity to women and minorities	2.7	3.6	4.3	3.0	3.8
Ethnic and gender diversity of the department	2.5	3.4	3.9	2.8	3.6
Ethnic and gender diversity of the university	2.5	3.3	3.8	2.8	3.4
Total student count	225	150	13	322	57

Table 4: Average scores for diversity considerations for gender and sexual minorities in student surveys.

Diversity considerations in recruitment activities. Faculty interviews indicated significant barriers to accepting international students into graduate positions. One faculty indicated that the application fees for international students were higher and may be a barrier, while two others commented on the difficulty judging international applications with different grading scales. Two faculty indicated the higher cost of international students on their own funding was a limiting factor for their own recruitment. One international student in the focus groups indicated that their direct email inquiry to a potential supervisor at the University got lost in junk mail. This student anecdote corroborated the result from the student surveys that indicated racial minorities placed higher importance in the admissions process when evaluating criteria for graduate school.

Websites were also found to be a more important source of information for racial minorities searching for graduate school information. Student surveys indicated that racial minorities ranked departmental and university websites higher to a statistically significant level in Table B8. It was noted as the only source of information for one international student: "For me [information is] basically just the website because visiting campus is something that is never possible for me". Another international student indicated the first impression of the website sets their impression of the university. Likewise, online communities, forums, blogs, and other first-hand online sources were rated higher in racial minority students to a statistical significance; however, these sources were not overall highly ranked at 11th of 17 for minority students.

Summary of Findings

Findings suggest that the decision-making process for students was dominated by information from faculty, graduate students and the departmental website. Students evaluating the alternatives of different graduate programs were generally concerned with academic staff,

cost, academic product and location considerations with very little interest in personal opportunities and diversity considerations. Differences between upper-year undergraduate, master's and doctorate students indicate higher importance for master's students on financial considerations and a steady decline of importance on the quality of teaching from first year to doctorate level.

Findings indicated a low awareness of the field of astroparticle physics and an uninspiring narrative of the field of research. The departmental website was found to be lacking quality information, aesthetic quality and ease of navigation. The information provided to students by faculty was very important and the friendliness they experienced through in-person contact with a potential supervisor supported their decision to accept an offer. Summer programs and campus visits were found to be good recruitment tools, however, not available for all students.

Diversity findings suggested that the website was more important for racial minorities including international students who may not have access to in-person information. Diversity sensitivity was found to be more important for gender and sexual minorities. Barriers to recruiting international students were found by faculty including financial considerations and difficulty applying admissions criteria to foreign transcripts.

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Analysis

The findings of the research uncovered decision-making implications and the effectiveness of recruitment activities for undergraduate and graduate physics students unique to the Canadian university context. The literature review presented results from previous studies in various contexts in other countries and fields of study in these areas. The following analysis highlights the commonalities and discrepancies between the literature and the current findings.

Models for Decision-making

Information Search. Findings agreed partially with the literature that the most effective sources of information for prospective graduate students were personal communications. Two studies found that promotional information was the least effective method of communication, agreeing with the findings placing faculty and student interactions at the top of the list, and focus group discussions citing interactions with supervisors as an important part of their journey into graduate school. Two other studies in the literature disagree with this finding, instead noting faculty interactions are less influential and instead recommending commercial promotional activities.

Evaluation of Alternatives. There is considerable overlap between literature and findings that indicated reputation as an important factor in student decision-making. Table 5 shows the top five student survey findings alongside the literature findings from Poock and Love (2001), Brennan (2001), and Stiber (2000) ranking student choice criteria. Reputation was ranked in the top five for two of the literature studies, and Stiber (2000) also agreed with the current study, in quality faculty to be an important factor in student choice. Overlap also exists in the highly-rated factor of the particular field of study in the student survey findings whose

counterparts can be interpreted as degrees offered, relevance and relevant curriculum in the top

five for the other literature sources.

Current Study	Poock and Love (2001)	Brennan (2001)	Stiber (2000)
3 rd year to doctorate level	Doctoral students in higher	Prospective general	Prospective business
physics students	education administration	graduate students	graduate students
(Canada)	(United States)	(Australia)	(United States)
Particular field of study	Location (close to home)	Degrees offered	Quality faculty
available			
	Friendliness of dept.	Location	Relevant curriculum
Research opportunities	faculty/staff		
Quality of the research	Availability of evening classes	Relevance	Respected school
facilities			accreditation
	Able to continue working in	Image or reputation	Responsive faculty
Tuition and cost	job		
Reputation of the	Flexible program	Job placement	Respected school
department's faculty	requirements.		reputation

Table 5: Top five evaluation criteria from the surveys of the current findings for third year to doctorate level physics students in Canada alongside literature findings from similar studies.

Gaps between the current findings and literature are also prevalent. The findings from the current study suggested that research opportunities and facilities are more important than in the literature. Post-graduate job placement was a diminishing concern from first- to fourth-year students, dropping after the master's level, in disagreement with the literature. Tuition and cost do not factor highly in the literature but rank fourth in the current study. Similarly, location is a top consideration for two of the literature studies, placed lower in eighth place for the current study. Findings disagreed with the literature which suggested that older graduate students rank personal factors such as spousal and child care more highly when making their decision (Kallio, 1995). For these factors, there were no statistically significant differences between undergraduate and graduate students, and in all cases were ranked very low.

The importance of financial support arose in both the present findings and the literature as a universal consideration. Faculty and students pointed towards a lack of funding for graduate students, especially for international students. The literature suggested that assistantships to diversity groups were the most effective means of student recruitment for underrepresented groups. This overlap with the findings shows it is an important consideration for minority and non-minority students alike.

Recruitment Activities

Organization and job attractiveness. Literature and findings agree that awareness of the field is an important aspect of graduate school decision-making. Literature emphasized early exposure to the organization before the information search formed the initial perception of a candidate's views. Faculty and undergraduate students in the current findings agreed familiarity with the field was lacking for prospective students. Likewise, the literature suggested a high reputation increase an applicant's decision to apply, agreeing with the findings that the neutral reputation of astroparticle physics and Queen's University research is limiting the growth of the applicant pool.

Website. The importance of the website as a recruitment tool overlapped in both the literature and the findings. The importance of the website information was highly rated by student surveys, student focus groups, and faculty interviews, in agreement with most of the literature results found in Brennan (2001), Dawes and Brown (2002), and Poock (2007) who all indicated the high importance of the website as a source of information. The literature from Allen et al. (2007) that the website may be more influential than the recruiter was seen in the current study, in which students rated information from faculty or another graduate student higher than the departmental website.

There was a significant overlap in the value of quality website information in the literature and the findings. Students and faculty indicated that there was a need for easier access to quality information online about the department, research groups, and faculty to increase the attractiveness of the graduate program. The literature agreed that a person is less likely to apply to a position if they have little or uncertain information about it.

Recruiter characteristics. The importance of the faculty in the recruitment effort is echoed in the literature and the findings. The positive impact of the personability and friendliness of faculty discussed by students and agreed with the literature that the quality of the interactions matters. Findings and literature also agreed that faculty interactions were more important than interactions with other graduate students as well. The reputation of the faculty was also a stronger driver for students, which agrees with Chapman et al. (2005) who found that in addition to personability, the perceived competence of a recruiter is related to the candidate's intention to accept an offer.

On-campus recruitment. The success of undergraduate research programs as a recruitment tool does not fully correlate with the literature. The findings suggested only a small number of students attend these programs, which diminished their overall impact. Contrarily for those students who did attend found them very impactful, in agreement with the literature of Griffin and Muñiz (2011) and Poock (2007) who suggested that on-site summer research programs were successful recruitment tools. The literature further discussed summer research as especially impactful for underrepresented students, which agrees with the finding that gender minorities rated these experiences more highly.

Similarly, to summer research, the importance of campus visits and tours do not fully align between literature and findings. The success of campus visits in the findings was mixed

given the low numbers of students who had the opportunity to attend, and the differences in individual supervisors organizing the visits. The literature suggested that negative behaviours during the site visit would dissuade an applicant due to poor organization, which agrees with the faculty views on the subject in the current study.

Diversity Considerations

Diversity considerations in decision-making. Most findings do not overlap with the literature when considering factors of diversity such as gender, race, and sexuality. The finding that racial minority students place a higher value in online sources of information is absent from the literature. Similarly, the finding of Poock and Love (2001) that diversity-related criteria are more important to racial minority students was not found in the current study. Likewise, the importance of diversity-related factors in decision-making, which were suggested to be small between women and men in the literature, were found to be much more important to gender minorities than men in the current study.

The literature that indicated on-site versus online recruitment methods were more successful for racial minority students, the opposite of which was found in the current study. Griffin and Muñiz (2011) suggested that campus visitation programs and on-site research programs were more influential for underrepresented backgrounds. Likewise, the literature disagreed with the finding that websites were rated more highly as a source of information for racial minority students in both student surveys and focus group students.

Diversity considerations in recruitment activities. There is mixed evidence in the findings that supports the literature of the similarity-attraction phenomenon in graduate student recruitment. The finding that diversity criteria are more highly valued by gender and sexual

minority students agrees with the similarity-attraction phenomenon found by Devendorf and Highhouse (2008). By contrast, the similarity-attraction phenomenon in racial and ethnic minority students in the surveys was not found but was present in a small number of focus group students. This is a mixed result when compared to the literature which found promotional materials using diverse images attracted more racial minority applicants.

Discussion

Models for Decision-making

Information Search. The importance of personal communications in a student's information search was found in all data collected in the current study, contrary to the mixed literature findings. In the context of the McDonald Institute and graduate physics studies, the faculty member is often so specialized that only they can provide accurate and engaging information about their field of research, making this mode of communication a necessary and widespread practice. The quality of the interactions and communications through the individual faculty, therefore, is a lever that should be used to increase the interest in applying to and accepting an admission offer. With similar expertise in the research areas, current graduate students were also found to have an important role in communicating with prospective graduate students according to this study's findings. The importance of the individuals' interactions, and not the organization, in this case, indicates a need for supporting individual faculty and graduate students with improved recruitment tools.

Evaluation of Alternatives. The quality and availability of specific research fields dominated the evaluation of alternatives in the student decision-making process. This is likely another symptom of physics having so many individual fields of expertise, one of which is astroparticle physics. This important finding that differs from the literature highlights the importance of knowledge and interest in astroparticle physics prior to the start of a student's decision-making process. Currently, the data suggests that the field of astroparticle physics is relatively unknown within undergraduate students, demonstrating a gap that must be closed for the McDonald Institute to recruit more graduate students. The previous analysis showed that financial barriers for international graduate students are higher than domestic students and just as relevant to their decision-making process. International students represent an opportunity to increase diversity in the department and open up the whole world to recruit from. Removing financial barriers from international students who are the least supported of the students entering graduate school through scholarships, assistantships or funding programs would support growth in this area of student recruitment.

Recruitment Activities

Organization and job attractiveness. Familiarity with the field of astroparticle physics was low in prospective graduate students. Given that undergraduate physics courses introducing particle or astroparticle physics at Queen's University do not start until the winter semester of third year (Department of Physics Engineering Physics & Astronomy, 2019), there is an opportunity for the McDonald Institute to control and push the familiarity with the field earlier to undergraduate students. Asserting this familiarity will create a larger pool of undergraduate physics students who have had ample time to consider astroparticle physics as a research area before entering their decision-making process. Examples of movement in this area already exist for arts students with a generalist approach to new topics in physics (University of Toronto Physics, 2019). Offering similar courses to physics-track students with more math and physics as part of their degree requirements across Canada would increase the applicant pool considerably and although time-consuming effort, is within the influence of the McDonald Institute through its affiliate faculty and staff members. Recruitment results from moving astroparticle physics into first or second year of undergraduate studies would take three to four years for master's and six to eight years for doctorate applicant pools to increase (Mulvey & Nicholson, 2014).

While the reputation of the field was found to be lacking, first-hand information was found to be very important for potential graduate students, indicating that word-of-mouth endorsements are an excellent leverage point for increasing the reputation of the field with potential graduate students. Current faculty and students interacting in the field at conferences, summer schools and in their everyday collaborations have the power to build the reputation of astroparticle physics and the research reputation of the individual universities they represent. Developing training or performance requirements for faculty and students to increase their wordof-mouth communication with prospective students and academics would represent a culture change. Faculty revealed in interviews that doing more in this area may not be met with open arms from all faculty, so a change management plan will likely be needed to successfully leverage faculty and student participation. The analysis indicated that the involvement of faculty is paramount to success in any recruitment efforts, and so carefully planning this change will be key to implementation.

The analysis suggested that the website is one of the most important sources of information for prospective students, especially international students. The McDonald Institute website, affiliate research pages, and faculty webpages are places within the influence or control of the McDonald institute where high-quality and current information should live. Current faculty websites are mostly small amounts of text-based information (however, some have improved considerably in the last year) and do not have a variety of mediums for engagement or the quality of information suggested by the literature to support the student decision-making process (Allen et al., 2007; Breaugh, 2013; Walker et al., 2012). The opportunity to include information specific to the faculty's field of research to entice prospective students is clear from the analysis section and can be updated quickly by individual faculty with copy-editing support

of the McDonald Institute. Modernization of the website design and appearance, specifically the Queen's Particle Astrophysics page, can create the impression for students of an up-and-coming field with the high-quality research that they are interested in.

Recruiter characteristics. The importance of the friendliness of faculty was found to be important in the later stages of recruitment. Friendliness acted more to seal the deal once the student had already decided to apply or contact the faculty through email, video chat or inperson, while reputation and online information played bigger factors earlier in the decisionmaking process. Friendliness and compatibility between graduate students and faculty, therefore, should be considered important to the decision to accept an offer, which can be influenced by recruitment activities such as campus visits organized by faculty, email conversations, and phone or video calls. With some faculty noting that this courtship process was awkward, support from the McDonald Institute to add ease into the process with organized visits or creating more comfortable social activities may improve the quality of faculty interactions with students and increase acceptance rates of pending offers.

On-campus recruitment. The influence of summer research programs was found to be effective in the literature and for the students who participated in the programs. The impact, however, was likely low due to the small number of students attending. The CAPSS program hosted by the McDonald Institute includes many ingredients for recruitment success including site visits to research facilities, interaction with faculty and graduate students, and growing interest and awareness of the field. Offering this opportunity to more students while maintaining the quality of the academics and experiences offered will increase the applicant pool of students in future years.

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Likewise, the summer program selection process offers an opportunity for encouraging students with high research potential who may not meet the more stringent grade requirements for graduate school. Developing new selection criteria for the summer program would open the field to more minority students who may show excellent potential not reflected in their grades. This opportunity to cultivate students earlier is an avenue that faculty can use to recruit non-traditional graduate students who may not have the top marks in the class, but who have the potential to out-perform their peers in the graduate school setting. With faculty indicating that students with the highest marks often chose a more prestigious school or program than Queen's University, summer programs offer an opportunity for a recruitment pipeline that values excellent students for qualities other than their class marks from a broader pool of applicants.

On-site campus visits were an influential factor; however, only a small number of students had this opportunity. Most campus visits were found to occur as part of the courtship of a student after they had decided to apply with a specific faculty member, and so hits only a small number of students. Literature suggested that campus visits can be used with a much larger pool of students before they apply to the program (Griffin & Muñiz, 2011; Poock, 2007), which is an opportunity to increase the interest in the program for the McDonald Institute. Allowing more students to meet with faculty, students and research labs are influential sources of information and evaluation criteria that would influence more students to apply after their visit. With a schedule that includes both social and academic activities, visiting the research labs as well as meeting faculty and students in-person would allow for some of most influential factors of a student's graduate school decision-making to be covered in one visit, and reduce the pressure on individual faculty to provide an engaging visit.

Diversity Considerations

Diversity considerations in decision-making. The importance of diversity issues for gender and sexual minorities and not for racial or ethnic minorities is a finding from this study that disagreed with the literature. This is likely due to a large number of male faculty and students in physics (Malcolm et al., 2007) which put other genders at odds with the dominant culture more prevalently than any racial or ethnic divides. Studies found that lower enrolment in women into the fields of science, technology, engineering, and math was due to the male-dominated culture signaling a lower female sense of belonging and a lack of early exposure for women in these fields (Cheryan, Ziegler, Montoya, & Jiang, 2017; Edzie, 2014), particularly in computer science, engineering, and physics (Cheryan et al., 2017). This suggests that in order to increase graduate student applications from women, there must be an effort to create inclusive departmental cultures and an early awareness of the field to girls and women.

A re-branding of science, technology, engineering, and math fields to include more societal or human-related outcomes of the research has been suggested by the literature to increase the applicant pool of women. In a longitudinal study of computer science students at Carnegie Mellon University, Fisher and Margolis (2002) increased the percentage of women entering undergraduate computer science classes from 7% to 42% in five years by offering courses that connected with the human side of computer science and actively working against the hacker-stereotype of male computer scientists to allow more women to see themselves in the field. Studies that looked specifically at women in the field of physics found that it may be necessary to re-brand physics as a field of science that contains social and political applications to open up the appeal to a larger number of women (Sax, Lehman, Barthelemy, & Lim, 2016). This suggests that increasing women-led narratives, including societal implications for astroparticle physics research and emphasizing women role-models in the field, will increase the number of women graduate student applications. Strides towards this have been made in a recent online article depicting astroparticle physics with a compelling narrative and diverse student images entitled "Dark Matter Detectives: The Hunt for the Missing Mass of the Universe" (Witten, 2019); however, a sustained effort for this brand of the field must be sustained to ensure that online information, campus visits, summer schools and personal interactions between faculty and students include these narratives and dispel stereotypes.

A male-dominated culture continues to exist in the sciences, unintentionally harbouring microaggressions towards women students and faculty alike (Anderson, 2017). Microaggressions found by Anderson (2017) included the invisibility of women, assumptions of the intellectual inferiority of women, and restrictive gender roles, often unintentionally delivered by male colleagues. Influencing departmental cultures to reduce gendered microaggressions will likely a more difficult lever for the McDonald Institute to access, given it is not directly involved with departmental cultures in affiliate universities; however, it can directly control the culture of its staff and faculty leaders to raise awareness of the barriers to women in the field. These tactics that encourage women to apply to astroparticle physics graduate programs will likely improve the overall quality of the program for all genders in the process.

Diversity considerations in recruitment activities. The analysis showed a gap between the expected similarity-attraction for racial and ethnic minorities in the literature and the findings. This indicates that depicting more diverse faculty, students and images in promotional materials may not be an effective avenue to increasing racial diversity in the student population. Gender minorities, however, were more influenced by issues relating to diversity and sensitivity

to women and minorities. This suggests that for marketing materials whose goals include increasing gender diversity, it is more impactful to depict both gender and racial minorities. The analysis suggested that similarity-attraction is likely to hold true for in-person interactions with faculty and students, therefore the best on-site recruitment programs would include gender and racial or ethnic minorities. The literature cautions, however, that the responsibility of increasing diversity of graduate students should be carried by all (Griffin & Muñiz, 2011), and follows that minorities must not be given a disproportionate amount of work in order to create similarityattraction influence in recruitment.

The analysis also suggested the importance of online information and admissions processes for racial and ethnic minorities who were also international students. In order to increase diversity through international students, the quality relevance of online information should address the specific needs of international students. This includes admission processes and transcript requirements that can be interpreted in the global context, financial support and information, highlights of living life in Canada, and using global instead of local research terms if applicable to increase the organizational attractiveness of the department or faculty for international students during their online search.

The prevalence of international students in the current study opens avenues to other methods of diversity recruitment. In the 2016/2017 academic year, Canada hosted 1.3 million international students, and 130,000 of which were in physical and life sciences, and technologies, a growth of 2.7% from the previous year (Statistics Canada, 2019). This is an area of student growth that can likewise grow within the astroparticle physics field. Online recruitment information including websites and social media strategies were found to be important to international student recruitment by Choudaha, Chang, and Kono (2013). They also found that

creating an admissions pipeline of students from undergraduate institutions internationally through partnerships with other universities increased the applicant pool.

Recommendations

Both long- and short-term recommendations follow the previous discussion.

Recommendations one to three are the longest and largest projects whose preliminary steps can commence immediately to create large, sustained changes for graduate student recruitment. Recommendations four to six are shorter-term tactics that can be completed in less time, with the most impactful projects presented earlier in each list of three.

Recommendation 1: Support Faculty with Recruitment Tools

Given the importance of student-faculty interactions, the quality of these should be increased in all stages of recruitment. Faculty should be supported with training or guidance on what information is most persuasive to use for recruitment both when students are searching for information, and later when they are considering an offer. Developing training or guidance for recruitment provides a tool for faculty to use. Likewise, training in recognizing behaviour or language that unintentionally creates microaggressions towards women or gender minorities should be provided with the McDonald Institute faculty to enhance their success in recruiting women students. Given the likelihood of resistance from faculty, a change management plan will be required to successfully implement these elements.

Recommendation 2: Create a Strategy to Re-brand Astroparticle Physics

Updated narratives that focus on the human and social implications of astroparticle physics are required to entice new students into the field, especially women. A re-branding strategy should include some commercial sources of information but focus primarily on faculty and students becoming ambassadors of the field, armed with compelling stories that show a diversity of researchers. The McDonald Institute should encourage faculty to engage in conversations with students, deliver seminars and be part of other in-person touchpoints to put a face to the research being conducted.

Recommendation 3: Introduce Students to the Field Earlier

The early awareness of the field of astroparticle physics must increase in order to attract a larger pool of prospective graduate students. In this long-term strategy, the McDonald Institute should work with its affiliate universities on physics curriculum updates to create familiarity with the field of astroparticle physics earlier for undergraduate students, including moving particle physics courses earlier into first- or second-year classes. To be most successful, all undergraduate physics programs across Canada should make these curriculum changes, which will require advocacy and administrative support from the McDonald Institute to influence the changes. A likely starting point is Queen's University where the McDonald Institute influence is strongest and can develop best practices for making changes in other universities. The payoff of this long-term effort will be a new wave of undergraduate students with exposure to the field and overall increased awareness of the field in Canada.

Recommendation 4: Improve Website Navigation and Quality of Information

Given the importance of the website in the decision-making process, online improvements are a top priority for recruitment. Personal faculty pages are an impactful area to include more information about their current research and field, current student stories and projects, the quality of research facilities they use, and reputation indicators such as awards and research publications. Images online should represent the diversity desired in the student body, with an emphasis on women and racial minorities depicted in photos. Narratives included online should likewise represent women role-models and the societal implications of the field of

astroparticle physics to attract more women to apply. Information that is pertinent to international students should be easily found that includes admission requirements, life in Canada, financial information and language easily understood in the global research community. Overarching changes to the design of the websites under McDonald Institute influence should also be prioritized (for example the Queen's Particle Astrophysics website) should be redesigned to appear modern and reflect the state-of-the-art research being conducted within the field.

Recommendation 5: Increase On-site Exposure for Students

The positive impact of on-site recruitment activities should be exploited to increase the size and diversity of the pool of applicants. The CAPSS program should be expanded to include more students and new recruitment guidelines to increase the pipeline of non-traditional undergraduate students who may have desirable qualities not reflected in their transcript marks. Ensuring that the program continues to focus on faculty and research facility interactions will play a key role in its future successes in graduate student recruitment. The ongoing performance of the program as a recruitment tool should be tracked and changes made based on the data as well as student and faculty feedback.

Coordinated visitation weekends for students before they apply to the program can also be used to reach more students and introduce them to the faculty, research and social aspects of the program. A standardized approach coordinated by the McDonald Institute will remove the burden from individual supervisors and increase the likelihood of a positive recruitment outcome. A coordinated approach will also allow for more representation from gender, racial and ethnic minority faculty as they can be pooled from a larger group across the department. Many local students are likely to have the resources to pay for in-province travel to campuses; however, to pull students nationally, a budget that subsidizes a portion of each student's travel and accommodations may be required given the value students place on financial support.

Recommendation 6: Increase Student Financial Support

Opportunities for scholarships and financial support should be created to provide an incentive for students to apply to the program and accept offers. Named scholarships from the McDonald Institute for graduate students will create prestige for the program, increasing the number of quality applicants. Likewise, the McDonald Institute can include racial, ethnic and gender minority requirements as scholarship criteria to further goals of equity, diversity, and inclusion combined with excellence in research.

Implementation

The recommendations include a spectrum of tactics that can be implemented over the coming year. Short-term implementations such as website updates will be successful for this year's 2020 recruitment; however, longer-term strategies are likely to begin having an effect on the 2021 application deadlines.

1. Support Faculty with Recruitment Tools

The McDonald Institute staff will internally develop a change management plan and recruitment training materials based on the recommendations in this report and engage an external agency to deliver gender sensitivity training. A budget is required for any external training provided and any performance incentives required for faculty.

Step	Month 1	Month 2	Month 3	Ongoing
Budgeting and change management planning				
Develop faculty recruitment best practices guide				
Hire external trainers for gender sensitivity				
Develop performance metrics for recruitment and				
faculty participation				
Coordinate faculty participation in training				
Deliver training sessions as required				
Track ongoing success measures				
Ongoing training refreshers for faculty				

2. Create a Strategy to Re-brand the Field

Re-branding will require monetary investment into McDonald Institute marketing

materials and supporting ambassadorship activities such as travel or miscellaneous

reimbursements. An investment of internal time by the marketing team is required to seek out

and develop new compelling narratives and to develop faculty and students into ambassadors of

the new brand.

Step	Month 1	Month 2	Month 3	Ongoing
Budgeting and project planning				
Develop narratives & marketing strategy				
Focus group test new narratives				
Training and brand roll-out to faculty and students				
Ongoing support for faculty ambassadorship				

3. Introduce Students to the Field Earlier

This long-term and time-intensive process will require administrative and advocacy

support from the McDonald Institute to implement curriculum changes at universities across

Canada. Beginning with Queen's University, these changes will improve recruitment outcomes

within four to six years of courses being implemented.

Step	Year 1	Year 2	Year 3	Ongoing
Budgeting and project planning				
Curriculum change processes developed for Queen's				
Develop new undergraduate course(s)				
Processes developed for targeted Canadian universities				
New courses delivered				
Implement steps across Canadian universities				

4. Improve Website Navigation and Quality of Information

The McDonald Institute will contract a web designer and assign an internal project coordinator to ensure faculty participation and an ongoing process for updating the website. Internal or external resources for copy-editing will be required to support the outlined diversity considerations in this report. This process can begin immediately to have outputs for 2020 recruitment efforts.

Step	Month 1	Month 2	Ongoing
Budgeting and project planning			
Web design and information templates created			
Faculty provide information			
Copy editing and image selection			
Website launch			
Ongoing website updates			

5. Increase On-site Exposure for Students

The resources to create a campus visitation program include a coordinator to develop the

activity schedule and ensure faculty participation. Budget to subsidize student travel and on-

campus activities is required.

Step	Month 1	Month 2	Month 3	Ongoing
Budgeting and project planning				
Develop cost model for students				
Develop activities and schedule				
Develop success metrics				
Promote offering to undergraduate students				
Recruit faculty and student presence				
Host visitation weekend				
Assess student and faculty feedback				
Track ongoing success measures				

Expanding the CAPSS program will require a budget to support larger student

participation and coordination from the McDonald Institute to implement recruitment guidelines.

Step	Month 1	Month 2	Month 3	Month 4	Ongoing
Budgeting and project planning					
Develop model to increase number of students					
Develop new recruitment guidelines					
Develop success metrics					
Promote the program to undergraduate students					
Host CAPSS program					
Track success measures ongoing					

6. Increase Student Financial Support

Creating a named scholarship that benefits minority students will require an annual

bursary budget as well as up-front logistical support from the McDonald Institute to implement a

scholarship with the universities and promote the opportunity.

Step	Month 1	Month 2	Month 3	Month 4	Ongoing
Set annual scholarship budget					
Confirm scholarship requirements with universities					
Develop scholarship criteria					
Develop application process and set deadline					
Promote scholarship					
Select recipient(s)					

Conclusion

This research paper explored the decision-making processes and recruitment activities for astroparticle physics graduate students for the McDonald Institute. In order to become a centre of excellence in astroparticle physics, building research capacity through graduate student recruitment has become a priority for the McDonald Institute alongside equity, diversity, and inclusion. Therefore, this research sought the answer to the question: *How can the McDonald Institute develop a recruitment strategy to increase the quantity and diversity of graduate students*?

The literature review focused on graduate student decision-making, recruitment tactics, and diversity considerations for both. The literature disagreed on whether commercial or inperson recruitment materials were more effective. Studies also disagreed on the specific factors important in student decision-making, with some overlap finding that faculty, academic product, reputation, and relevant degree program were all important at some level. Organizational attractiveness was found to increase with reputation and quality of online information, while friendly faculty recruiters and on-campus programs were found important to effective recruitment. Differences were found with racial minorities who placed more importance on non-academic factors, in-person contact, financial considerations, and admissions processes. The similarity-attraction phenomenon was found for racial, ethnic, and gender minorities in recruitment material.

Based on this previous literature, new research was designed to explore the McDonald Institute graduate student context student surveys, student focus groups, and faculty interviews. Surveys were sent to 1839 undergraduate and 885 graduate physics students with 423 and 218 surveys quantitatively analyzed from the respective student groups across Canada. Student focus

groups were run for 20 undergraduate and graduate students at Queen's University to uncover qualitative information about their experiences and five faculty interviews were performed to better understand the barriers and opportunities to graduate student recruitment.

Findings suggested that in-person faculty and online sources dominated the information search for most students, which agreed with much of the literature. The top evaluation criteria for physics students were found to be academic staff and product, cost, and location. Faculty interviews further re-enforced the financial considerations important for students, which were a higher barrier for international students. The awareness of the field of astroparticle physics was found to be low with a neutral reputation amongst students and faculty and the quality of website information found to be lacking. Personal contact with friendly faculty and on-campus experience were found to be effective recruitment tools in both the literature and for physics graduate students. Racial and ethnic minorities were found to place more importance on website information, while gender and sexual minorities placed more importance on social and diversity factors, which are both findings that disagreed with the literature.

The gaps between the research and literature in evaluation criteria were discussed further, with differences found in racial, ethnic and gender minorities. The racial and ethnic differences between findings and literature were hypothesized to be due to a large number of international students identifying as racial and ethnic minorities, as well as the large gender disparity of women in the academic physics field. Literature suggested online information would better serve international students and that creating a new narrative for the field of astroparticle physics to include social implications of the research would better serve women and increase the applicant pools of both.

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Six recommendations were made based on the most impactful activities for the McDonald Institute to develop a recruitment strategy. These included three long-term strategies for supporting faculty with recruitment tools and training, creating a strategy to re-brand astroparticle physics, and introducing students to the field earlier. Shorter-term tactics were recommended for improving website navigation and quality of information, increasing on-site exposure for students and increasing student financial support.

Future directions to continue expanding may lie in the deeper development of diversity personnel strategies beyond graduate school. Developing a hiring and retention strategy of gender minorities at the faculty level will improve the graduate recruitment efforts by providing role-models, narratives and shift stereotypes of the male-dominated field while continuing to support the McDonald Institute's diversity, equity, and inclusion goals. With the present shortand long-term recommendations and considerations for the future, the McDonald Institute is well-positioned to implement a successful graduate student recruitment strategy that will build capacity in astroparticle physics in Canada.

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Appendix A – Questions for Student Surveys, Focus Groups and Faculty Interviews

Undergraduate Student Survey Questions

Undergraduate Student Survey

Thank you for taking this 10-minute survey that will support research benefitting graduate student recruitment, equity, diversity and inclusion at the Arthur B. McDonald Canadian Astroparticle Physics Research Institute.

To enter a draw to win a \$50 Amazon gift certificate, please include your email address in the field provided at the end of this survey.

ELECTRONIC SURVEY INFORMED CONSENT

This research is aimed to benefit the number and diversity (ethnic, gender, sexual, and ability) of students recruited into the field of astroparticle physics research, a benefit to the Arthur B. McDonald Canadian Astroparticle Physics Research Institute (McDonald Institute) to contribute more quality and quantity of research outputs of astroparticle physics in Canada.

Your participation is completely voluntary and whether you choose to participate or not will have no effect upon your academic grades and standing. If you do choose to participate, you are free to withdraw from the survey at any time prior to submission. Please note, once you have submitted the survey and the data becomes part of an anonymized dataset, it cannot be withdrawn. Similarly, if you choose not to participate in this research project, this information will be maintained in confidence.

The survey is expected to take 10 to 15 minutes to complete and will refer to your choices after graduation from your undergraduate program. The survey is an online survey and results will be summarized, in anonymous format, in the final report. Your comments will remain anonymous, unless you agree to be identified.

All documentation will be kept strictly confidential, however anonymized, aggregated responses, may be shared with the McDonald Institute, who is a knowledge user of the current study. In the event that your survey response is processed and stored in the United States, you are advised that its governments, courts, or law enforcement and regulatory agencies may be able to obtain disclosure of the data through the laws of the United States.

This research is being conducted by Melanie Hall in the Master of Business Administration program at Royal Roads University. Should you wish to be provided with a summary of the research and insights, please send a request to <u>melanie.7hall@royalroads.ca</u> who can provide this to you when the study is complete. You may verify the authenticity of this project by contacting the Academic Advisor of this research, Alicia Shively at <u>alicia.shively@royalroads.ca</u>. In addition to submitting the final report to Royal Roads University in partial fulfillment for the MBA degree the research findings will also be shared with the McDonald Institute.

An electronic copy, with no public access, will be held at Royal Roads University, unless the client has indicated the report is to be returned for confidentiality reasons. In certain circumstances, the report may be reviewed by future MBA students, provided permission has been obtained from the report writer.

Next

Diversity, equity and inclusion information

Please provide some information about yourself so we can better understand the diversity, equity and inclusion of the student population.

What year of university are you currently enrolled in? *
1st year undergraduate
2nd year undergraduate
3rd year undergraduate
4th year undergraduate
5th year undergraduate
Other:
What is your academic major? *
Please select all that apply: *
Female
Male
Transgender
Non-binary / genderqueer
Prefer not to say
Other:
Do you self-identify as a member of a racialized or visible minority? *
Yes
No
Prefer not to say
Please select all that apply: *
White/Caucasian
Black (e.g., African, American, Canadian, Caribbean)
Hispanic/Latino
Metis
First Nations
Indigenous person from outside Canada
Chinese
Japanese
Korean

MCDONALD INSTITUTE RECRUITMENT

	South East Asian (e.g., Burmese, Cambodian/Kampuchean, Laotian, Malaysian, Thai, Vietnamese, Indonesian)
	South Asian/East Indian (e.g., Bangladeshi, Pakistani, Indian from India, East Indian from Guyana, Trinidadian, Sri Lankan, East African)
	Non-White West Asian (e.g., Iranian, Lebanese, Afghan)
	Filipino
	Non-White North African (e.g., Egyptian, Libyan)
	Arab
	Non-White Latin American (including indigenous persons from Central and South America)
	Prefer not to say
	Other:
D	o you identify as member of a sexual minority group? *
	Yes
	No
	Prefer not to say
	Gay Straight (heterosexual) Lesbian Pansexual Queer
	Questioning or unsure
	Prefer not to disclose
	Other:
D	o you identify as a person with disabilities? *
	Yes
	No
	Prefer not to say
Н	ave you considered applying for graduate school after graduation? *
	Yes
	No
	If no, please share any reasons why you have not considered graduate school (optional):

Graduate School Preferences

Since you have considered applying for graduate school, please tell us a bit more about what you have thought about.

When weighing the benefits and opportunities of different universities, programs and fields of study, each person places value on different criteria involved in their choice. Please indicate how you rated each of the following criteria when evaluating your choice to apply to any institution's graduate program: 1 - Not a consideration; 2 - Not very important; 3 - Neutral; 4 - Important; 5 - Very Important

Institution's academic reputation
Variety of course offerings
Value of a degree from the school
Geographic location
Social / cultural opportunities
Quality of the research facilities
Day-to-day campus life
Admissions process
Sensitivity to women and minorities
Ethnic and gender diversity of the university
Ethnic and gender diversity of the department
Size of the department
The particular field of study available
Reputation of the department's faculty
Quality of teaching
Research opportunities
Quality of students enrolled in the program
Opportunities for friendships
Opportunities to teach
Opportunity to work with specific faculty member
Interest of a faculty in recruiting me
Friendliness of department faculty/staff
Post-graduate job placement
Program structure and requirements
Length of time to degree completion
Work/school availability for spouse/partner
Input from your spouse/partner
Availability of child care

r		-			-	
	1	2	3	4	5	Unclear

Availability of housing Availability of financial aid Amount of stipend provided Tuition and cost Other factors which were very important or important:

Reflecting on your final decision to enroll in your current graduate program, what factor do you believe was the most important to you and why?

Graduate Student Survey Questions

Graduate Student Survey

Thank you for taking this 15-minute survey that will support research benefitting graduate student recruitment, equity, diversity and inclusion at the Arthur B. McDonald Canadian Astroparticle Physics Research Institute.

To enter a draw to win a \$50 Amazon gift certificate, please include your email address in the field provided at the end of this survey.

ELECTRONIC SURVEY INFORMED CONSENT

This research is aimed to benefit the number and diversity (ethnic, gender, sexual, and ability) of students recruited into the field of astroparticle physics research, a benefit to the Arthur B. McDonald Canadian Astroparticle Physics Research Institute (McDonald Institute) to contribute more quality and quantity of research outputs of astroparticle physics in Canada.

Your participation is completely voluntary and whether you choose to participate or not will have no effect upon your academic grades and standing. If you do choose to participate, you are free to withdraw from the survey at any time prior to submission. Please note, once you have submitted the survey and the data becomes part of an anonymized dataset, it cannot be withdrawn. Similarly, if you choose not to participate in this research project, this information will be maintained in confidence.

The survey is expected to take 10 to 15 minutes to complete and will refer to your choices after graduation from your undergraduate program. The survey is an online survey and results will be summarized, in anonymous format, in the final report. Your comments will remain anonymous, unless you agree to be identified.

All documentation will be kept strictly confidential, however anonymized, aggregated responses, may be shared with the McDonald Institute, who is a knowledge user of the current study. In the event that your survey response is processed and stored in the United States, you are advised that its governments, courts, or law enforcement and regulatory agencies may be able to obtain disclosure of the data through the laws of the United States.

This research is being conducted by Melanie Hall in the Master of Business Administration program at Royal Roads University. Should you wish to be provided with a summary of the research and insights, please send a request to <u>melanie.7hall@royalroads.ca</u> who can provide this to you when the study is complete. You may verify the authenticity of this project by contacting the Academic Advisor of this research, Alicia Shively at <u>alicia.shively@royalroads.ca</u>. In addition to submitting the final report to Royal Roads University in partial fulfillment for the MBA degree the research findings will also be shared with the McDonald Institute.

An electronic copy, with no public access, will be held at Royal Roads University, unless the client has indicated the report is to be returned for confidentiality reasons. In certain circumstances, the report may be reviewed by future MBA students, provided permission has been obtained from the report writer.

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Diversity, equity and inclusion information

Please provide some information about yourself so we can better understand the diversity, equity and inclusion of the student population.

What year of graduate studies are you currently enrolled in? *	
Master's 1st year	
Master's 2nd year	
Doctorate 1st year	
Doctorate 2nd year	
Doctorate 3rd year	
Doctorate 4th year	
Other:	
What is your field of research? *	
Please select all that apply: *	
Female	
Male	
Transgender	
Non-binary / genderqueer	
Prefer not to say	
Other:	
_Do you self-identify as a member of a racialized or visible minority? *	
Yes	
No	
Prefer not to say	
Please select all that apply: *	
White/Caucasian	
Black (e.g., African, American, Canadian, Caribbean)	
Hispanic/Latino	
Metis	
Inuit	
First Nations	
Indigenous person from outside Canada	
Chinese	
Japanese	
Korean	

MCDONALD INSTITUTE RECRUITMENT

	South East Asian (e.g., Burmese, Cambodian/Kampuchean, Laotian, Malaysian, Thai, Vietnamese,
	South Asian/East Indian (e.g., Bangladeshi, Pakistani, Indian from India, East Indian from Guyana, Trinidadian, Sri Lankan, East African)
	Non-White West Asian (e.g., Iranian, Lebanese, Afghan)
	Filipino
	Non-White North African (e.g., Egyptian, Libyan)
	Arab
	Non-White Latin American (including indigenous persons from Central and South America)
	Prefer not to say
	Other:
D	o you identify as member of a sexual minority group? *
	Yes
	No
	Prefer not to say
Р	lease identify your sexual orientation: *
	Asexual
	Disexual
	Gay
	Lesblan
	Pansexual
	Queer
	Preter not to disclose
	Other:
D	o you identify as a person with disabilities? *
	Yes
	No
	Prefer not to say

Graduate school preferences

Please provide some information about your personal preferences when choosing a graduate program for your most recent degree.

The answers you provide in this section relate to any school, program or specialty you considered in your most recent choice.

For example, if you are in a PhD program, please answer in relation to any schools programs, or specialties you considered for that choice (which may have been different from when you chose your Master's program).

When considering graduate studies, you likely consulted with multiple sources of information to make your decision between schools, programs or specialties. Please rate the importance you placed in the information sources from any institution or program you considered in your decision: 1 - Not a consideration; 2 - Not very important; 3 - Neutral; 4 - Important; 5 - Very Important

University brochure (paper/electronic) Departmental brochure (paper/electronic) Information from your previous undergraduate program faculty Information from faculty within the department of interest Another graduate student within the department Departmental website University website Online communities, forums, blogs or other first-hand online sources Friends / family Graduate student fair Promotion or advertisement Academic conference Attending a summer research program with the department Attending a summer research program outside of the department Campus visit or tour First-hand information obtained through the interview process Information through your current undergraduate or graduate enrollment in the same program/department

Other sources of information which were very important or important:

When weighing the benefits and opportunities of different universities, programs and fields of study, each person places value on different criteria involved in their choice. Please indicate how you rated each of the following criteria when evaluating your choice to apply to any institution's graduate program: 1 - Not a consideration; 2 - Not very important; 3 - Neutral; 4 - Important; 5 - Very

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rtant									
1	2	3	4	5	Unclear				

Important

Institution's academic reputation Variety of course offerings Value of a degree from the school Geographic location
Variety of course offerings Value of a degree from the school Geographic location
Value of a degree from the school
Geographic location
Social / cultural opportunities
Quality of the research facilities
Day-to-day campus life
Admissions process
Sensitivity to women and minorities
Ethnic and gender diversity of the university
Ethnic and gender diversity of the department
Size of the department
The particular field of study available
Reputation of the department's faculty
Quality of teaching
Research opportunities
Quality of students enrolled in the program
Opportunities for friendships
Opportunities to teach
Opportunity to work with specific faculty member
Interest of a faculty in recruiting me
Friendliness of department faculty/staff
Post-graduate job placement
Program structure and requirements
Length of time to degree completion
Work/school availability for spouse/partner
Input from your spouse/partner
Availability of child care
Availability of housing
Availability of financial aid
Amount of stipend provided
Tuition and cost
Other factors which were very important or important:

Reflecting on your final decision to enroll in your current graduate program, what factor do you believe was the most important to you and why?

2 3

1

4 5

Unclear

Thank you!						
The experience and details you've shared are contributing to the advancement of physics and particle astrophysics in Canada.						
If you would like to enter your email address to win a \$50 Amazon gift certificate, please leave your email address below. We value and appreciate your time and trust in providing insight into our survey. Collection of e-mail addresses will exclusively be used for the above draw and will not be retained, used for any other purposes, nor will it be associated with your responses.						
Back Submit Page 5 of						

Undergraduate Focus Group Guide Questions

OPENING QUESTIONS

- 1. Take a moment to reflect on when you first thought that you were interested in physics or sciences.
 - Relating to the field of work or personal values, what inspired you to want to pursue physics in your undergraduate degree?
- 2. Do you consider graduate school as a potential future for you?
- 3. What factors might you be weighing if considering graduate school vs. a job vs. other options? Please elaborate on those options if applicable.

HANDOUT SECTION

- 4. What academic, social and other factors were most important to you when comparing different graduate programs?
 - In YELLOW, please indicate for ANY program, and in PINK, please indicate for your CURRENT program.
 - Can anyone share one or two of the factors they considered and elaborate a bit?

- 5. What sources of information would or will be the most important to you when deciding whether to attend graduate school, or which school or program to attend?
 - Please take a moment to read through the list highlighting in YELLOW which of these factors was important or very important.
 - Can anyone share one or two of the sources of information they considered and elaborate a bit?

DISCUSSION QUESTIONS

- 6. How long do you think it will or was to make your decision to apply or not?
- 7. Have you considered astroparticle physics as a field of research? Why or why not?

Graduate Student Focus Group Guide Questions

OPENING QUESTIONS

- 1. Take a moment to reflect on when you first thought that you were interested in physics or sciences.
 - Relating to the field of work or personal values, what inspired you to want to continue in physics past your undergraduate degree?
- 2. When did you first consider graduate school as an option for you, and how did this come about?

HANDOUT SECTION (see student survey questionnaire)

- 3. What academic, social and other factors were most important to you when comparing different graduate programs?
 - In YELLOW, please indicate for ANY program, and in PINK, please indicate for your CURRENT program.
 - Can anyone share one or two of the factors they considered and elaborate a bit?
- 4. What sources of information were most important to you when you were choosing your graduate school? This can be for ANY graduate school, not just this one.
 - Please take a moment to read through the list highlighting in YELLOW which of these factors was important or very important.
 - In PINK highlighter, please indicate which of these were factors which made you choose your CURRENT program and department?
 - Can anyone share one or two of the information sources they considered and elaborate a bit?

DISCUSSION QUESTIONS

- 5. What was your recruitment experience like here or at other institutions?
 - Were there any highlights?
 - Were there any barriers?

- 6. How would you rate your overall recruitment experience with your current department at Queen's?
 - What made it that way?
- 7. Why do you think other students from your undergraduate or graduate programs didn't choose to apply or enroll in this department or field?
- 8. What suggestions do you have for recruitment staff and faculty to improve their processes?

Faculty Interview Guide Questions

- 1. How many new graduate students do you normally supervise each year? This year?
- 2. How did you recruit this year's students?
- 3. How did you recruit past students?
- 4. Which is most effective?
- 5. What barriers do you face in recruiting more graduate students?
- 6. What opportunities do you see as most promising for increasing the number of graduate students recruited?
- 7. What efforts do you see around diversity, inclusion and equity in your department?
- 8. Do you think they are/have been effective at increasing diversity?
- 9. What support do you have from the department or university for carrying out graduate student recruitment?
- 10. If you had a million dollars to spend (or unlimited funds), how would you use it to increase the number of graduate students in your department?

Appendix B – Student Survey Data

Undergraduate Intention to Apply to Graduate School

Academic Major (all years)	No	Yes	Total	% Yes
Physics Majors & Specializations	19	178	197	90%
Engineering /Applied Science	4	48	52	92%
Biology and Physics	1	47	48	98%
Mathematics & Physics	3	43	46	93%
Astronomy and Astrophysics		30	30	100%
Chemistry & Physics		15	15	100%
Computer Science & Physics	1	9	10	90%
Other Sciences		5	5	100%
Social Sciences		5	5	100%
General Sciences	1	3	4	75%
Education		4	4	100%
Undecided		3	3	100%
Not Answered		3	3	100%
Total	29	393	422	
Percentage Total	7%	93%		93%

Table B6: Undergraduate student survey responses to the question "Have you considered applying for graduate school after graduation?"

Reasons not Considered Graduate School

Reason	Student Count
Not required for career path	7
Undecided	5
Financial reasons	2
Need a break	2
Don't like it	1
Grades	1

Table B7: Undergraduate student survey reasons given for not considering graduate school after graduation.

Sources of Information		Year of Studies			
Sources of Information	MSc	Ph.D.	Total		
Information from faculty within the department of interest	4.4	4.4	4.4		
Another graduate student within the department	4.0	3.9	4.0		
Departmental website	3.9	3.8	3.8		
Information from your previous undergraduate program faculty	3.9	3.6	3.8		
First-hand information obtained through the interview process	3.7	3.8	3.7		
Information through your current undergraduate or graduate enrollment in the					
same program/department	3.5	3.3	3.4		
University website	3.4	3.0	3.2		
Attending a summer research program with the department	3.4	2.8	3.1		
Campus visit or tour	3.2	3.0	3.1		
Academic conference	3.2	2.8	3.0		
Friends / family	2.8	2.8	2.8		
Attending a summer research program outside of the department	2.7	2.6	2.6		
Departmental brochure (paper/electronic)	2.6	2.6	2.6		
Online communities, forums, blogs or other first-hand online sources	2.5	2.5	2.5		
Graduate student fair	2.3	2.4	2.4		
University brochure (paper/electronic)	2.3	2.2	2.2		
Promotion or advertisement	2.1	2.0	2.0		
Total Student Count	95	122	217		

Sources of Information for all Master's and Doctorate Students

Table B8: Importance of information sources considered when applying to graduate schools. Colour is scaled to the average score, with statistically significant differences between groups indicated as bold and bordered cells.

Undergraduate Graduate Criteria 5th+ 1st 2nd 3rd 4th MSc Ph.D. Total The particular field of study available 4.6 4.7 4.6 4.7 4.7 4.6 4.5 4.7 **Research** opportunities 4.5 4.6 4.5 4.4 4.4 4.7 4.6 4.6 Quality of the research facilities 4.5 4.5 4.3 4.4 4.3 4.6 4.5 4.5 Tuition and cost 4.1 4.1 4.0 4.2 4.2 4.4 4.2 4.2 Reputation of the department's faculty 4.1 4.2 4.1 4.1 4.3 4.3 4.0 4.1 Quality of teaching 4.7 4.7 4.5 4.5 4.2 4.1 3.7 4.3 Value of a degree from the school 4.0 4.2 4.3 4.2 4.2 4.2 4.1 4.2 Geographic location 3.8 3.7 3.8 3.8 4.3 4.3 4.2 4.0 Institution's academic reputation 4.0 4.0 4.0 3.9 3.9 4.3 4.0 4.0 Amount of stipend provided 3.3 3.5 3.6 3.8 3.8 4.3 4.2 3.8 Friendliness of department faculty/staff 3.9 3.9 4.0 4.0 3.8 4.0 4.0 4.0 Opportunity to work with specific faculty member 3.7 3.9 3.5 4.1 4.2 3.9 3.6 3.8 Interest of a faculty in recruiting me 3.8 3.9 4.0 3.9 3.8 4.1 3.9 3.9 Diversity of course offerings 4.1 3.9 3.9 3.8 3.7 3.9 3.8 3.8 Program structure and requirements 4.0 4.1 4.0 3.9 4.0 3.9 3.5 3.9 Availability of financial aid 3.7 3.7 3.7 3.8 3.8 3.8 4.1 3.7 Post-graduate job placement 4.3 4.2 4.0 4.0 3.9 3.6 3.4 3.9 Length of time to degree completion 3.7 3.6 3.8 3.6 3.7 4.0 3.7 3.5 Quality of students enrolled in the program 3.8 3.7 3.5 3.6 3.3 3.7 3.4 3.6 Day-to-day campus life 3.8 3.4 3.6 3.4 3.5 3.5 3.1 3.7 Opportunities to teach 3.4 3.4 3.4 3.7 3.1 3.4 3.4 3.4 **Opportunities for friendships** 3.4 3.4 3.7 3.6 3.6 3.1 3.3 3.2 Social / cultural opportunities 3.3 3.0 3.2 3.3 3.0 3.3 3.2 3.4 Admissions process 3.4 3.3 3.2 3.3 3.5 3.4 3.2 3.3 Availability of housing 3.4 3.3 3.3 3.4 3.4 3.1 3.1 3.2 Size of the department 2.9 3.3 2.9 3.1 3.0 3.3 3.2 3.1 Sensitivity to women and minorities 3.5 3.1 3.2 3.1 3.1 3.0 3.1 3.2 Ethnic and gender diversity of the department 3.2 2.8 2.9 3.0 2.8 2.9 2.9 2.9 Ethnic and gender diversity of the university 2.9 2.9 2.9 2.8 3.2 2.9 2.8 2.9

Evaluation Criteria for All Students

Work/school availability for spouse/partner

Input from your spouse/partner

Availability of child care

Total Student Count

Table B9: Evaluation criteria average Likert scores for all program levels, colour-scaled by score.

2.9

2.8

2.0

117

2.6

2.4

1.8

128

2.6

2.5

1.7

93

2.7

2.5

1.8

58

2.9

2.8

1.9

26

2.5

2.5

1.8

95

2.7

2.8

1.9

122

2.7

2.6

1.8

640

Sources of Information by Minority Identification

		Gend	er Identifi	cation	
Sources of Information				Prefer	
			Other	not to	
	Male	Female	Identity*	say	Total
Information from faculty within the department of interest	4.4	4.4	4.3	4.0	4.4
Another graduate student within the department	3.8	4.1	4.0	3.0	4.0
Departmental website	3.8	3.9	4.3	5.0	3.8
Information from your previous undergraduate program faculty	3.9	3.6	4.0	1.0	3.8
First-hand information obtained through the interview process	3.7	3.8	4.0	1.0	3.7
Information through your current undergraduate or graduate enrollment in the same program/department	3.3	3.7	4.3	1.0	3.4
University website	3.1	3.5	2.8	4.0	3.2
Attending a summer research program with the	2.0	3.1	3.0	1.0	2.1
department	2.9	3.4	J 5.0	1.0	5.1
Campus visit or tour	3.1	3.1	3.0	4.0	3.1
Academic conference	2.8	3.3	2.8	3.0	3.0
Friends / family	2.7	3.1	2.5	2.0	2.8
Attending a summer research program outside of the department	2.5	2.9	3.3	1.0	2.6
Departmental brochure (paper/electronic)	2.5	2.9	2.5	1.0	2.6
Online communities, forums, blogs or other first-hand online sources	2.4	2.6	3.3	2.0	2.5
Graduate student fair	2.3	2.4	2.3	1.0	2.4
University brochure (paper/electronic)	2.1	2.4	2.3	1.0	2.2
Promotion or advertisement	1.9	2.1	2.3	<u>1</u> .0	2.0
Total Student Count	134	78	4	1	217

Table B10: Sources of information for master's and doctorate students grouped by gender identification. Statistically significant differences are indicated in bold and outlined. *Other identity category includes transgendered, non-binary and genderqueer responses.

	Racial and Ethnic Minority Identification					
Sources of Information	Prefer					
	No	Yes	not to say	Total		
Information from faculty within the department of interest	4.4	4.3	4.3	4.4		
Another graduate student within the department	3.9	4.1	4.0	4.0		
Departmental website	3.8	4.2	3.9	3.8		
Information from your previous undergraduate program faculty	3.7	4.0	3.3	3.8		
interview process	3.8	3.6	3.8	3.7		
Information through your current undergraduate or graduate enrollment in the same	510	5.0	5.0			
program/department	3.4	3.4	3.1	3.4		
University website	3.0	3.9	3.1	3.2		
Attending a summer research program with the department	3.0	3.4	3.2	3.1		
Campus visit or tour	3.0	3.5	3.3	3.1		
Academic conference	3.0	3.0	3.3	3.0		
Friends / family	2.7	3.5	2.3	2.8		
Attending a summer research program outside of the department	2.5	3.0	2.9	2.6		
Departmental brochure (paper/electronic)	2.6	2.8	2.0	2.6		
Online communities, forums, blogs or other first- hand online sources	2.4	3.2	2.3	2.5		
Graduate student fair	2.4	2.3	2.2	2.4		
University brochure (paper/electronic)	2.2	2.4	1.4	2.2		
Promotion or advertisement	2.0	2.2	1.8	2.0		
Total Student Count	172	36	9	217		

Table B11: Sources of information for master's and doctorate students grouped by racial and ethnic minority identification. Statistically significant differences are indicated in bold and outlined.

	Sexual	Minority	y Identifi	cation
Sources of Information			Prefer not to	
	No	Yes	say	Total
Information from faculty within the department of interest	4.4	4.3	4.5	4.4
Another graduate student within the department	4.0	3.8	4.5	4.0
Departmental website	3.8	3.9	4.3	3.8
Information from your previous undergraduate program faculty	3.7	3.9	3.6	3.8
First-hand information obtained through the interview process	3.7	4.0	3.3	3.7
Information through your current undergraduate or graduate enrollment in the same program/department	3.4	3.4	3.5	3.4
University website	3.2	3.1	3.6	3.2
Attending a summer research program with the department	3.1	3.0	2.8	3.1
Campus visit or tour	3.1	3.3	3.3	3.1
Academic conference	3.0	2.6	3.3	3.0
Friends / family	2.8	2.6	3.0	2.8
Attending a summer research program outside of the department	2.6	3.1	3.0	2.6
Departmental brochure (paper/electronic)	2.7	2.2	2.8	2.6
Online communities, forums, blogs or other first-hand online	2.5	2.6	2.2	2.5
sources	2.5	2.6	3.3	2.5
Graduate student fair	2.4	2.1	3.1	2.4
University brochure (paper/electronic)	2.2	2.0	2.1	2.2
Promotion or advertisement	2.0	1.7	3.0	2.0
Total Student Count	188	21	8	217

Table B12: Sources of information for master's and doctorate students grouped by sexual

minority identification. Statistically significant differences are indicated in bold and outlined.

MC

CDONALD INSTITUTE RECRUITMENT	

	Gender Identification			
Evaluation Criteria		Fomolo	Other Idontity*	Total
The particular field of study available			10entity ·	10tal
Research opportunities	4.6	ч.7 Д б	т. 0 Л.Л	ч.7 Д б
Quality of the research facilities	4.0 A A	4.5		т. 0 Д Д
Tuition and cost	4.7	4.2	4.3	4.2
Reputation of the department's faculty	4.2	4.1	4.0	4.1
Quality of teaching	4.0	43	43	4.1
Value of a degree from the school	4.1	4.1	3.8	4.1
Geographic location	4.0	4.1 4.1	2.0 4.3	4.1 4.1
Institution's academic reputation	4.0	4.1	4.5 4.1	4.1
Amount of stipend provided	4.0	4.0	4 3	4.0
Friendliness of department faculty/staff	4.0	4.0	4 3	4.0
Opportunity to work with specific faculty member	4.0	4.0	3.8	4.0
Interest of a faculty in recruiting me	4.0	3.9	3.4	3.9
Diversity of course offerings		3.8	4.0	3.8
Program structure and requirements		3.9	4.0	3.8
Availability of financial aid		3.9	4.1	3.8
Post-graduate job placement		3.7	3.8	3.7
Length of time to degree completion		3.7	3.6	3.6
Quality of students enrolled in the program	3.6	3.5	3.5	3.5
Day-to-day campus life	3.4	3.7	3.3	3.5
Opportunities to teach	3.4	3.5	3.4	3.4
Opportunities for friendships	3.2	3.6	3.5	3.4
Social / cultural opportunities	3.2	3.5	3.6	3.3
Admissions process	3.2	3.3	3.2	3.3
Availability of housing	3.1	3.4	3.7	3.2
Size of the department	3.1	3.2	3.7	3.2
Sensitivity to women and minorities	2.7	3.6	4.3	3.1
Ethnic and gender diversity of the department	2.5	3.4	3.9	2.9
Ethnic and gender diversity of the university	2.5	3.3	3.8	2.9
Work/school availability for spouse/partner	2.5	2.8	2.4	2.6
Input from your spouse/partner	2.6	2.7	2.5	2.6
Availability of child care	1.7	2.1	1.3	1.8
Total Student Count	229	151	13	395

Evaluation Criteria by Minority Identification

Table B13: Gender minority segmentation for evaluation criteria Likert score averages for all students third year and above. Statistically significant differences are indicated in bold and outlined. *Other identity category includes transgendered, non-binary and genderqueer responses.

MCDONALD INSTITUTE RECRUITMENT

	Racial and Ethnic Minority Identification			
Evaluation Criteria	Prefer not			
	No	Yes	to say	Total
The particular field of study available	4.7	4.6	4.4	4.7
Research opportunities	4.6	4.6	4.5	4.6
Quality of the research facilities	4.4	4.4	4.6	4.4
Tuition and cost	4.2	4.3	4.0	4.2
Reputation of the department's faculty	4.1	4.2	3.8	4.1
Quality of teaching	4.1	4.2	3.6	4.1
Value of a degree from the school	4.1	4.3	4.0	4.1
Geographic location	4.1	4.0	3.8	4.1
Institution's academic reputation	4.0	4.1	4.2	4.1
Amount of stipend provided	4.0	4.2	3.9	4.0
Friendliness of department faculty/staff	4.0	3.9	4.2	4.0
Opportunity to work with specific faculty member	4.0	3.9	4.3	4.0
Interest of a faculty in recruiting me	3.9	3.9	3.9	3.9
Diversity of course offerings	3.8	3.9	3.6	3.8
Program structure and requirements	3.8	3.8	3.4	3.8
Availability of financial aid	3.8	4.0	3.4	3.8
Post-graduate job placement	3.7	3.7	3.9	3.7
Length of time to degree completion	3.6	3.7	3.5	3.6
Quality of students enrolled in the program	3.5	3.6	3.6	3.5
Day-to-day campus life	3.5	3.4	4.1	3.5
Opportunities to teach	3.4	3.6	3.4	3.4
Opportunities for friendships	3.4	3.5	3.2	3.4
Social / cultural opportunities	3.3	3.4	3.3	3.3
Admissions process	3.2	3.5	3.6	3.3
Availability of housing	3.1	3.4	3.1	3.2
Size of the department	3.2	3.0	3.4	3.2
Sensitivity to women and minorities	3.0	3.3	3.2	3.1
Ethnic and gender diversity of the department	2.9	3.0	3.1	2.9
Ethnic and gender diversity of the university	2.9	2.9	3.1	2.9
Work/school availability for spouse/partner	2.7	2.5	2.4	2.6
Input from your spouse/partner	2.7	2.4	2.5	2.6
Availability of child care	1.8	1.8	1.9	1.8
Total Student Count	298	81	16	395

Table B14: Racial and ethnic minority segmentation for evaluation criteria Likert score averages for all students third year and above. Statistically significant differences are indicated in bold and outlined.

	Sexual Minority Identification			
Evaluation Criteria			Prefer	
	No	Voc	not to	Total
The particular field of study evailable	110	1 es	say	10tal
Descende apportunities	4.7	4.7	4.4	4.7
Research opportunities	4.0	4./	4.5	4.0
Quality of the research facilities	4.4	4.4	4.5	4.4
Tutton and cost	4.2	4.5	3.8	4.2
Reputation of the department's faculty	4.2	4.0	3.9	4.1
Quality of teaching	4.1	4.5	3.8	4.1
Value of a degree from the school	4.1	4.0	4.2	4.1
Geographic location	4.1	4.1	4.1	4.1
Institution's academic reputation	4.1	3.9	3.9	4.1
Amount of stipend provided	4.0	4.3	3.8	4.0
Friendliness of department faculty/staff	4.0	4.1	3.8	4.0
Opportunity to work with specific faculty member	4.0	3.8	4.2	4.0
Interest of a faculty in recruiting me	4.0	3.5	3.7	3.9
Diversity of course offerings	3.8	4.0	3.9	3.8
Program structure and requirements	3.8	4.0	3.4	3.8
Availability of financial aid	3.8	4.0	3.3	3.8
Post-graduate job placement	3.7	3.8	3.9	3.7
Length of time to degree completion	3.6	3.7	3.5	3.6
Quality of students enrolled in the program	3.6	3.4	3.4	3.5
Day-to-day campus life	3.5	3.7	3.5	3.5
Opportunities to teach	3.4	3.6	3.3	3.4
Opportunities for friendships	3.4	3.5	3.1	3.4
Social / cultural opportunities	3.3	3.4	3.4	3.3
Admissions process	3.3	3.3	3.0	3.3
Availability of housing	3.1	3.6	3.1	3.2
Size of the department	3.1	3.4	3.1	3.2
Sensitivity to women and minorities	3.0	3.8	3.3	3.1
Ethnic and gender diversity of the department	2.8	3.6	3.2	2.9
Ethnic and gender diversity of the university	2.8	3.4	3.3	2.9
Work/school availability for spouse/partner	2.7	2.3	2.9	2.6
Input from your spouse/partner	2.7	2.1	2.8	2.6
Availability of child care	1.8	1.6	1.8	1.8
Total Student Count	322	57	16	395

Table B15: Sexual identity segmentation for evaluation criteria Likert score averages for all students third year and above. Statistically significant differences are indicated in bold and outlined.

Appendix C – Focus Group Data

Participants numbers 1 to 7 are master's students, 8 to 14 are doctorate students, 15 to 20 are undergraduate students.

Problem Recognition

Participant	Comment summary
Participant 1	• Both parents have graduate degrees, was always interested in physics.
Participant 2	• Always thought physics in the long-term was the goal.
Participant 3	• Started Master's for fear of missing out, started in the "four plus one" program
Participant 4	• Always assumed a master's would be required because of industry requirements and is also highly recommended in the military.
Participant 5	• Other people don't know what astronomy is and they had the personality to do research instead of interacting with other people.
Participant 6	• Decided on Master's in fourth year undergraduate.
Participant 7	• Wanted to dive deeper into physics, only so much you can get from undergraduate.
Participant 8	 Knew engineering was an option, in high school realized physics was an option and discovered the field. Always thought graduate school was next step, never knew you could do other jobs with the degree.
Participant 9	• Undergrad decision based off high school realization they enjoyed space and that astronomy was a career option.
Participant 10	 Loved physics but had teachers tell them they weren't good enough Had to choose between art and physics
Participant 11	• Disliked physics in high school, but engineering and physics in undergraduate made instrumentation focus for graduate school.
Participant 12	Enjoyed physics as a child.Graduate school was always the plan
Participant 13	• Enjoyed math and physics in high school, transitioned to engineering in undergraduate then particle astrophysics in graduate school.
Participant 14	• Was an obvious choice since first year of university
Participant 15	• Graduate degree makes you competitive in the workforce, at least a Master's, in nuclear, aerospace.
Participant 16	 Would like to be a professor so knows they need a graduate degree. Still unsure of exact details.
Participant 17	• Doesn't know exactly what they like, is taking extra time in undergraduate program to figure out what field they want to do.

Participant 18	 Difficult to make the choice for graduate school without knowing all the topics in physics, they only know the basics, not all the different options available (only recently took quantum). Would be interested in doing a Master's with courses that allow for a more solid foundation. Hard to say right now that particle astrophysics is the field they are interested in.
Participant 19	• Looking at graduate school as an option to travel
Participant 20	• Doesn't know all options but thinking about nautical engineering which seems good so far.

Information Search

Participant	Comment summary
Participant 1	• Asked specific faculty for information when applying
Participant 8	• Supervisors from work placement told them about the option of Queens existence as a graduate school.
Participant 9	 Looked at major university astronomy departments, faculty and research areas and narrowed down from there. Looked first at research area, then specific faculty when applying.
Participant 10	• Saw many paper authors from Queens when working with SNO+, so started to think Queens was worthwhile.
Participant 13	• Talking with friends in the program helped
Participant 14	• Did research with different profs first before choosing to apply
Participant 15	• How the supervisor is and what they expect you can't find in a brochure, which is important
Participant 17	 Family input and campus tour are most important. Has used current profs as a resource for information. Talking to students is more authentic, especially if not a formal setting, and they have more details.
Participant 18	 By the time emailing a supervisor happens, they have already focused in on the school, so easily accessible website or other sources would be needed first. They have also asked current undergraduate faculty at Queens about supervisors at other universities.
Participant 19	• Hearing from student already in the program is less biased, student will tell you the good and the bad. Finding the students at an academic conference for example.
Participant 20	• Current students give the best unbiased opinions

Evaluation of Alternatives

Participant	Comment summary
Participant 1	• Made friends at Queens, a big factor for staying.
	• Enjoyed the campus environment more than the others he saw on

	tours.
Participant 2	Looking for specific research opportunities. Undergrad school did
	not offer the opportunities.
	Other people have more modern physics buildings
	Not a factor, wanted to start a fresh page
Participant 3	• Enjoyed the content
	• Supervisor day-to-day is important
	Partner located at Queens largely factored into decision
Participant 4	• To learn more about particle physics.
	• A lot of PI's and experiments at Queens
	• Being close to SNOLAB is an advantage
Participant 5	• Enjoyed the hot topic in galactic dynamics offered by supervisor
1	• Flexible programs in Canada compared to US, and quick transfer
	system
	• Canadian social environment is better than US including racial
	profiling, discrimination and violence
	 Canada was important as a location, and Kingston is guieter.
Participant 6	• Research facilities aren't great. NanoFab centre is far from
	campus. McMaster has it closer
	• Wanted to leave undergraduate university and get a degree from
	somewhere different
	• Others she knew thought Oueens was too small
Participant 7	• Liked SNO+ experiment and people
Participant 8	• Flexibility to create a split astroparticle/astro program was
•	appealing.
	• The building is pretty old, facilities are not as advanced, office
	spaces not as nice.
	Getting better laptops would be nice.
	• Staff to support finding scholarships would be helpful.
Participant 9	• working with specific faculty members important. Didn't care
•	about anything other than the person when they arrived.
	• A window in the office would be nice.
	• Computers not provided to students, monitors, resources, laptop
	you could take to conferences or do simulations with.
	• Was drawn to the school with the interactions he had with
	students and staff on campus tour.
Participant 10	• Financial support information on the website would be helpful.
1	• As international student, the lack of social events was very
	difficult, since no friends or family, and few courses with other
	students.
	• Grad chair is now organizing events, which is great.
	• Jealous of the SNO+ group having the best time ever.
Participant 11	• Lab space was nice
r ···	• Got into a school where he did not like the environment first and

	left.
	• City would be nicer.
	• Updates to the infrastructure would be nice.
Participant 12	• Was given the opportunity to work on his own projects as well, which sealed the deal.
	• Buildings look like paint ball arenas.
	 Being in your 30s, scraping by on rent and food affects you. Other friends are making money and financially secure.
	• Information about housing opportunities and care that graduate students are given is better than other departments.
	 North America was the geographic choice, rather than Europe Would have preferred a bigger city
Participant 13	Passing up a job opportunity can be difficult financially
Participant 14	 Liked supervisor from undergrad, particular field of studies also important
	Mainly chose Queens because of Supervisor
Participant 15	• Field of study most important, for interest and passion.
	• Friendships important, but unsure how to evaluate for that in
	advance.
Participant 16	• "The most important thing for me is that diversity of the city the university in the department. "
Participant 17	• Haven't yet had time to think about it.
	• Friendliness is important.
	• Specific field along with the faculty member is most important
Participant 18	• Wants the faculty to be friendly and care about you as a person.
	• "you want to think that the people who will be supervising you
	actually care about what you care about and that you're doing
	well. And you want them to be friendly."
	SNOLAB seems like you may spend more time cleaning detectors and seeking perfection than they might like
Participant 19	• Meeting different people in a different location is important as part of life, more than just academic choice.
Participant 20	• Just focused on academics, friendships and partner considerations not part of it.

Reputation

Participant	Comment summary
Participant 1	 Queens not a top school in the world, the excellent students won't go there. Excellent students would have better discussions in departments better than Queens.
Participant 2	 Co-op placement students recommended Queens. Nobel prize helped decision, although working at SNOLAB was

	main
Participant 3	• Doesn't think school reputation is important, only when you're
	done.
	• Reputation of Queens doesn't match reality of the research
	quality.
	• U of T is larger and a more well-known name, but isn't important
	to him.
Participant 5	 Queens reputation internationally and in China not as good as it should be.
	• Queens doesn't rank with schools like UBC, U of T, McGill.
	• Other students may not have applied because of reputation.
	Knew about Nobel Prize.
	• Thinks reputation is the number one driver for recruitment.
Participant 6	• Queen's reputation isn't that great
Participant 7	• Art McDonald and the Nobel prize and the government funding
-	made him optimistic for particle physics field at Queens.
Participant 8	Past supervisors recommended Queens.
Participant 9	• Thinks Nobel Prize should give better recognition now because
-	more people are aware in physics community.
Participant 10	Did not know of Queens before working on SNO+
-	internationally.
	• Had heard of the Nobel Prize coming from Queens.
	• Never saw anyone at conferences in France from Queens.
Participant 11	• Nobel prize winning helped him recognize Queens as an option
-	• Queens doesn't come up as a school known for quality of
	research.
	• Needs a bigger international presence.
	• Thought Queens was an undergraduate party school before
	coming.
	• Doesn't think Nobel Prize helped that much.
Participant 12	• First contact through the website makes the first impression.
	• Queens doesn't have a bad reputation, just no reputation at all,
	people don't know it exists.
Participant 13	• Thinks Queens doesn't do enough to promote itself.
Participant 15	• Reputation of astroparticle physics is that it is data-heavy, so
	drives them away from the field, they are looking more to the
	engineering mechanical side.
	• Enjoys the experimental side much more than data-analysis side.
Participant 16	Doesn't know enough about astroparticle yet.
Participant 17	• Knows a bit about particle astrophysics because of a TA, online
	and talking to faculty.
Participant 18	• Seems like at SNOLAB you may spend more time perfecting
	detector accuracy and cleaning them, makes them shy away from
	the field.

Participant 19	•	Doesn't know anything about astroparticle physics but knows
		someone who worked at SNOLAB.

Website

Participant	Comment summary
Participant 2	SNOLAB website is terrible
Participant 3	• SNOLAB website is pretty bad
Participant 4	• Online portion of application slowed things down, made it more difficult.
Participant 5	• Could only use website because visiting was not an option
Participant 6	• Website was main or only source of info.
	• SNOLAB website is not user-friendly as other universities
Participant 7	 Documents hard to find on Queens website
	• Thinks people from elsewhere need a good website to get them to apply.
Participant 8	• Disappointed with all departmental websites.
	• More detail on their own website was a strong factor to know
	what they're doing.
	• More updated departmental website would be useful.
	• Sees website as a barrier.
	• More specific information on the website about the day-to-day,
	program structure, student stories, graduated students, faculty
D (11)	information.
Participant 10	Include financial support information on the website.
Participant 12	• Website could be better and is important as the first contact.
	• Having helpful paragraphs on the webpage for MSc students,
	because they do not know how to look up their papers to
	understand their research. Summaries of papers.
Doutining out 15	Catchy website that covers everything (lacking at Queens)
Participant 15	• Physics website is a bit old, but not bad, math one is bad.
Participant 16	• Online is the best place for information, since in-person
Dentieinent 19	interactions are more difficult for them.
Participant 18	• would use the website as first source of information before
Deuticineut 20	emailing supervisors
Participant 20	• I hinks a website update would be useful, because they look like
	they're from the 90s. Comical that they can offer advanced
	physics but can't have a nice-looking website.

Recruiter Characteristics

Participant	Comment summary
Participant 1	Good relationship with advisor
Participant 3	Individual supervisor is most important

Participant 4	• Brilliant and nice people, got to know them first
Participant 5	Advisor is a 'smart guy'
Participant 8	 Enthusiasm from supervisor was helpful in making decision to accept
Participant 9	• Drawn to the university based on staff and student interactions
Participant 10	• Friendliness in interview was the decision-maker, and student asked for a second interview
Participant 12	 Supervisor seemed really nice, interview was deciding factor. Friendliness at Queens is more than at other places. Had a bad experience in Master's with bad supervisor, so this was more important.
Participant 13	Talking to faculty was most important part
Participant 14	• Thought supervisor was smart and made decision because of them
Participant 15	• Person recruiting for undergraduate Queens was passionate and they remember talking to him.

Recruitment Process

Participant	Comment summary
Participant 1	Queens had straightforward recruitment
Participant 2	 Queens acceptance came a month later than other schools, was a negative. Queens was also late in undergraduate application. Had to re-send transcripts twice. Had to re-apply once started because of the HR graduate system. Didn't have time to do a campus tour because the acceptance came too late to arrange one before the deadline.
Participant 3	 Ease of the Queens four plus one program was a big factor. Application was easy because it was a formality, almost don't remember applying.
Participant 4	 Prospective supervisor promptly replied and had in-person meeting. School lost the transcripts.
Participant 5	 Application difficult as a foreign student, email went to junk folder of supervisor. Had a video call after the junk mail incident, received offer two hours after and went well. Graduate assistant staff were friendly and made visa and documents easier.
Participant 6	• Accidentally applied to the wrong program.
Participant 7	• Bureaucracy seems to slow things down.
Participant 8	• Responsiveness of communication was an indication that they were really wanted as a student
Participant 12	• Was excited by the reply from supervisor, length of detail, time

	they took and showed interest, available shortly after on Skype.
Participant 15	 Company end of year is Christmas, school end of year is April/May, so timing clashes. Would apply as early as possible to graduate school so that they have the option at least.
Participant 16	• Summer position at TRIUMF was accepted in January, so didn't apply to any Queens positions whose applications were due after that.
Participant 17	• Feels industry creates earlier deadlines on purpose, to get a job for sure.
Participant 18	 Companies for summer jobs hire by Christmas, whereas summer academic jobs have a Christmas deadline for application. Makes it difficult to turn down a job if offered in the hopes of getting a summer position later. Thinks academia comes out on losing end of the timing clash. Currently in the process of creating applications for graduate school, but they aren't due for another 3-4 months.
Participant 19	• Will probably look into graduate deadlines this year [they are in 3rd year] and apply next year

Recruitment Methods

Participant	Comment summary
Participant 1	• Enjoyed undergrad, so stayed at Queens.
	• Thinks people don't apply because of their grades
Participant 2	• worked at SNOLAB through Waterloo coop, liked it
	• Students who worked at SNO+ for the summer or coop consider
	going to Queens
Participant 3	 liked the working environment and working with hands
Participant 4	• Got to know the profs and thought they were good people
	• RMC cross-appointed profs, got to know campus
	• Astroparticle physics summer school helped find a supervisor,
	was good source of information
Participant 6	• Enjoyed undergrad courses. Thought at least Master's is required
	for jobs.
Participant 7	• Undergrad thesis was a transition to Master's
	• Summer position at SNO+ made him want to stay in third year,
	gave him MI experience and information.
Participant 8	Suggests that coop programs from Waterloo are good ways to
	recruit.
Participant 11	• 80% of new students have done summer programs at Queens or
	SNOLAB.
	Waterloo is a big recruitment cohort.
Participant 15	• Undergraduate university fair was helpful to talk to different

	people, even though was probably biased.
Participant 17	Campus tour would be important
Participant 19	• Has never heard of a graduate student fair.

Diversity Recruitment

Participant	Comment summary
Participant 5	• Canadian social environment is better than US including racial profiling, discrimination and violence
Participant 6	• There is a lack of diversity, not many South Asians, Indians or brown people. Her friend worried she wouldn't feel part of a community.
Participant 16	 "I'm tired of all my professors being white men." Would use diversity surveys on university websites, however they are hard to find.
	• Being able to see diversity on campus is not always possible with sexual orientation, so the diversity survey is needed.
Participant 17	 Would be looking at diversity of graduate school, relating to females in the field. Agrees that the diversity survey should be more accessible.
Participant 18	 Doesn't look at diversity of faculty, believes that faculty aren't chosen on the basis of their diversity (white men). Believes it is difficult to maintain diversity and be equitable.
Participant 19	 Would be difficult as a female to go into teaching if no other females on faculty. Thinks perhaps graduate fairs would be a place to meet faculty and assess diversity.

Student Recommendations

Participant	Comment summary
Participant 1	• Partnership with other country's astroparticle groups for internships to increase reputation and increasing international partnerships.
Participant 2	• Hosting an academic conference to get people on-site, and a trip to SNOLAB.
Participant 5	Advocate for Queens more overseas
Participant 8	• Invest in non-academic staff to help more after the acceptance
Participant 9	• Course-based master's that could be marketed as elite with Art McDonald. Something prestigious.
Participant 10	 Thinks they don't go to enough academic conferences internationally. Neutrino theory course would help. Not aware of summer schools available for Doctorate schools.

Participant 11	• Thinks summer schools are the number one way to increase
	reputation and also recruit graduate students.
Participant 12	Bigger online presence to boost research reputation.
	• Art McDonald could agree to teach a class.
	• Astroparticle master's program (like the Perimeter Institute PSI
	master's) with MI opportunities specifically in experiment or
	theory, added bonuses other places don't.
	• Bigger diversity of courses would help, for example no QFT
	(Quantum Field Theory) courses.
	• Could have lectures and notes from last year's courses available
	online.
Participant 15	• Recommends a third year, second semester workshop on how to
	apply to graduate schools and what the opportunities are.
Participant 17	• Something that gives more information about graduate school in
	third year would be good, before you start applying.
Participant 18	• If graduate schools told 3rd year students they were interested in
	them without formal commitment, so that they feel some sort of
	security and not feel they have to apply for industry jobs.
	 Could have a Queens representative go to all the different
	schools, perhaps as an alliance, because people are interested in
-	going to different schools after undergraduate.
Participant 20	• Campus tours to meet new faculty that are subsidized with a
	group of students traveling together would be helpful.

Appendix D – Fa	culty Interview	Data
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Information Source

Faculty	Comment summary
Faculty 1	• Will promote a bit when going to other universities and at
	conferences like CUPC and women in Science.
	• There used to be a pre-application that students could submit that
	anowed them to know if they would be considered by the
	done with individual faculty when student email them.
Faculty 2	• No longer uses conferences to recruit, as they saw no positive effects.
Faculty 3	• Attends undergraduate fairs across the country four times per year to recruit.
	• Early exposure to the field is lacking.
	• Particle astrophysics isn't taught until Fall 4 th year at Queens,
	however is included in 3 rd year courses at Toronto, so that students
	get an earlier understanding of the subject matter. They have
	advocated for this type of earlier teaching in the curriculum in the
	past.
	• Undergraduate summer school has run the past two years, meant in
	part to be a recruitment tool for graduate studies, after seeing
	similar success for the Waterloo quantum computing summer
T 1/ 4	school. Have not seen the recruitment success rates tracked.
Faculty 4	• Has had success with a student through the summer program, and through word-of-mouth in the department.
	• Faculty webpage is where most of the students contact them from
	• There is no theoretical particle astrophysics webpage, although has
	tried to get one, not enough faculty to have enough content.
	 McDonald Institute website could be better in how the place the job advertisements perhaps.
	• One student found the listing on the McDonald Institute page.
	• Prefers recruitment where the student contacts directly, rather than
	going through the applications that come in.
Faculty 5	• Has students come for campus tours, and shows them team
	activities, dinners and exciting plans for the projects.

Reputation

Faculty	Comment summary
Faculty 1	 Queen's Physics ranks 12th in Canada on international ranking surveys, and very low amongst all countries, it is not seen as
	reputable in the world.
	• Particle astrophysics field is perhaps lacking a sales pitch that
	excites people about the field, and suspects faculty from other
	fields aren't encouraging students enter into this field as much.
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	• Believes the Queen's reputation for research is undervalued, when similar US departments are ranked much higher in the ranking surveys.
Faculty 3	 Pride in having a strong particle research program. Did the Nobel Prize winning make it harder to excite people about the field because they feel the problem is now solved? We haven't solved it we've just opened it up. People usually think the research is exciting, so inclined to think it it's about exposure, that we are doing a disservice to our students in promoting. At MIT, they teach a first-year program in modern physics, including dark matter and neutrino physics, that allows students to get excited early about the field. Has expressed this as a possible
Faculty 4	 vision for the future new building project. Oueens doesn't have a reputation internationally and is required to
5	recruit more and better students.
	• Nobel Prize helped within the field of neutrino physics
	experimentalists, however in particle physics overall, doesn't provide any recognition.
	• The field is exciting because they are trying to understand what the universe is made of.
	• Hasn't given many public talks, and not about the field in general.
Faculty 5	• Queens physics may be suffering from a low reputation because of
	the hiring decisions being made, where centralized decision-
	making from a leader could lead to better results.

Recruitment Methods

Faculty	Comment summary
Faculty 1	• Faculty can usually only afford a finite number of students (say one
	in a given year), so they can't put two offers out at the same time without risk.
	• Applications start coming in December, peak in January, however usually wait until McGill and Toronto are in the mix before
	offering too early, or else students may accept, then say no when
	they receive a better offer.
	• Is proactive about applications coming in to email promising ones to start dialog and encourage them, or help them complete their application if information is missing.
	• Tells students the job they take between third and fourth year will
	be instrumental in telling them what they can do.
Faculty 2	• Seems more difficult to recruit students in Canada/Queens than
	other countries.
	• Tried many recruitment methods early on (ex: conferences),

	however saw no effect, so uses more passive applications coming
	through the department
	• Graduate chair goes to CUPC and Women in Physics conferences
E	to recruit
Faculty 3	There is no actual application deadline, applications are accepted all year-round, although it may suggest a date for full consideration.
	• Have tried a webinar in the past that was unsuccessful.
	• Attends undergraduate fairs across the country four times per year to recruit.
	• Some of the best students come from the Engineering Physics
	 Thinks the website isn't good.
	• Undergraduate summer school has run the past two years, meant in
	similar success for the Waterloo guantum computing summer
	school Have not seen the recruitment success rates tracked
Faculty A	Wabsite is likely to need incremental changes rather than one large
I acuity 4	• Website is fixery to fleed incremental changes rather than one large overhaul. Some changes in the works are photos, program
	descriptions up to date text.
	 Has had one student tour campus however it was an awkward
	experience for them as there weren't many people in their group.
	• Finds that attracting students who are on the fence about the
	position to work with them is awkward and that if they are too
	enthusiastic the student loses interest.
	• Their field of study isn't a degree that is available – needs approval
	to have a Theoretical Particle Astrophysics degree.
Faculty 5	• Website is key; however the website is not good.
-	• Recruitment relies heavily on the departmental websites.
	• Need a web designer to create the promotional web portion for the
	physics department.
	McDonald Institute seminar program is not well advertised, only
	exists as a sub-page of one faculty's website.
	• Energy is required from faculty to do the extra work it takes to
	make these things happen on the website, seminar series, etc.
	• Faculty have to learn by osmosis how to recruit and supervise
	students, or have the personality to do it.

Diversity

Faculty	Comment summary
Faculty 1	 There is a tool the department was using to monitor equity, diversity and inclusion efforts, but not sure where this has gone to. Queen's physics is doing better in racial minority diversity than
	gender diversity because of the number of international students.

	• Larger pools of applicants like the summer school are easier to be selective about diversity, but small number statistics of graduate applications make this difficult.
Faculty 2	 Sees gender imbalance in the department, and suspects it is also in graduate students. Other countries such as Italy and France do not seem to suffer from the gender imbalance of Canada in their departments, anecdotally could be due to daycare in Ontario. Foreign students are at a disadvantage because of how much they cost the university and faculty members as well as how difficult it is to judge their applications with different scales and recommendation letters. Number of domestic students increases the funding the university receives from the Ontario government. Girls summer camp is a good initiative to start the interest early, a good long-term game that could help the field, however puts more burden on the female faculty in the department to do this along with their other work.
Faculty 3	 Very low applicant pool of women. International student CVs and transcripts are less transparent, so they often arrange a Skype or phone call in advance to help before they apply.
Faculty 4	 At the faculty level there is a gender imbalance, however not in the visible minorities. Tries hard to create a diverse group yet has ended up with three male students anyway.

Financial

Faculty	Comment summary
Faculty 1	 Application fee to apply for domestic students ~\$100, but may discourage students who are also applying to larger, better schools from applying until they hear back from them (McGill, Toronto) International application fees and student fees are much higher and may be a barrier International students do not receive NSERC or OGS funding so are often making less than similar domestic students An international scholarship for the McDonald Institute may improve this recruitment
Faculty 2	 Foreign students are at a disadvantage because of how much they cost the university and faculty members as well as how difficult it is to judge their applications with different scales and recommendation letters. Number of domestic students increases the funding the university receives from the Ontario government.

Faculty 3	 International students cost twice as much as the usual \$24,000 per student, and the department can only fund 11 students currently. McDonald Institute provides funding for the researcher to cover student costs, which may only be 9-10,000 per student. Some students choose higher U.S. salaries, even if the take-home salary is the same or less than a Canadian school, it seems more lucrative. Providing a student scholarship from MI as extra incentive would be excellent, however would need to find ways to ensure the University cut doesn't diminish the returns for the student (ex: only 2,000 of a 5,000 NSERC grant goes to the student).
Faculty 4	 International students face extra tuition and a reduced stipend because of it, which is a problem because would like to recruit from a wider pool of applicants to get the very best. May be difficult to provide international funding for students through McDonald Institute, with the funding coming from the Canada First Research Excellence Fund whose goals are domestic.
Faculty 5	• NSERC funding looks for researchers who take on students and mentorship, however if faculty aren't doing this early in their careers, it may be difficult to recover. Younger profs at MI are doing this well.

Opportunities

Faculty	Comment summary
Faculty 1	• Recruiting international students who are falling through the cracks when applying to other schools. The master's program at Queen's is an opportunity for them to show their brilliance.
Faculty 2	• Increasing the pool of applicants to choose from, by being more competitive or getting word out to undergraduates more.
Faculty 3	 Capture the imagination of students earlier through undergraduate curriculum changes to include particle or astroparticle earlier to capture more excellent students into the field. Named scholarship for students may provide financial incentive and prestige. Better advertising and website are needed.
Faculty 4	• Would recommend an organized campus tour with more than one student.