Galaxy Scaling Relations with Integral Field and Fibre Spectroscopy Surveys

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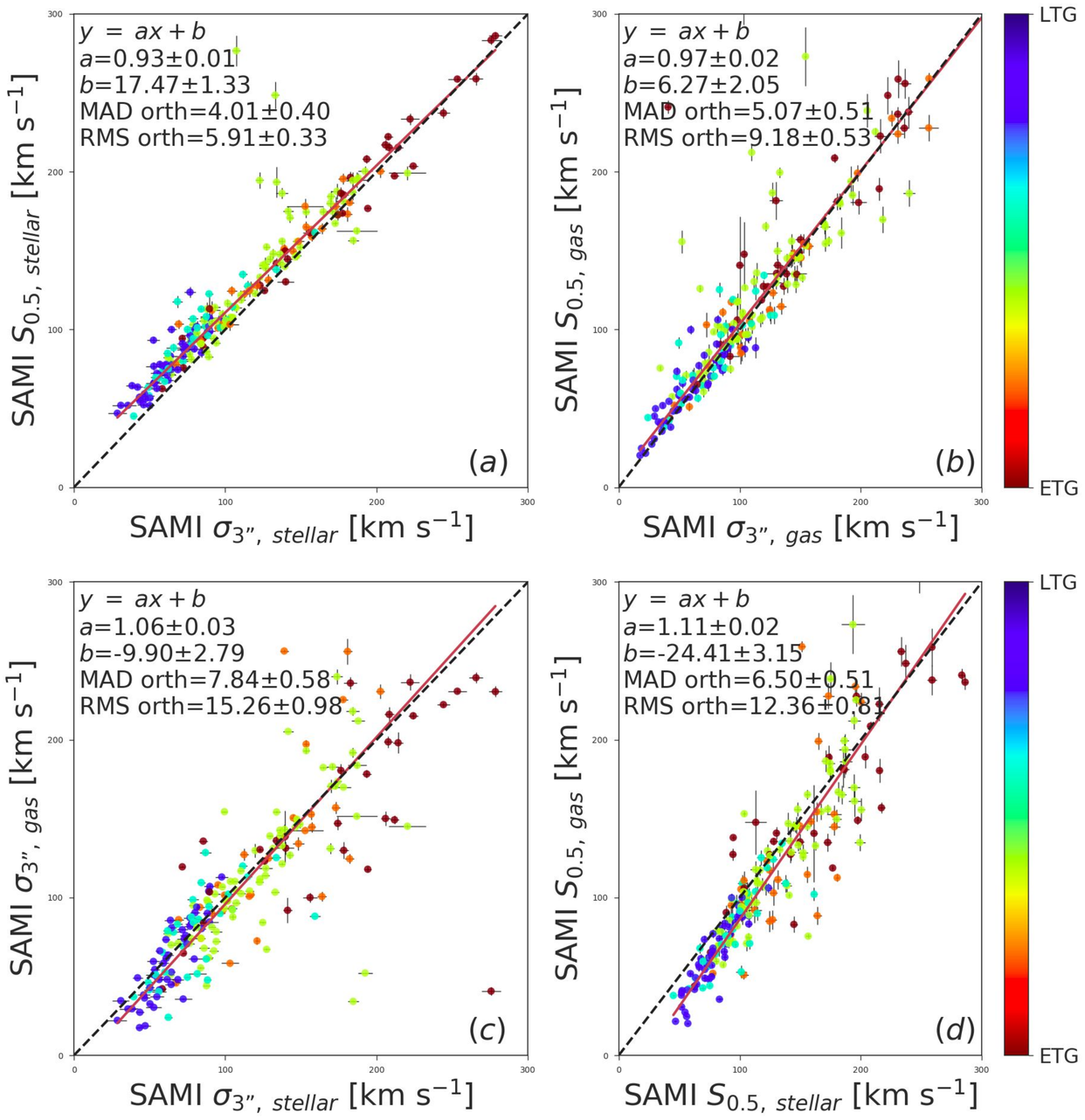
Recent studies of the $S_{0.5} = \sqrt{0.5 \cdot V_{rot}^2 + \sigma^2}$ kinematic parameter have shown the possibility of constructing a generalised galaxy scaling relation that applies to galaxies of all morphologies. However constructing $S_{0.5}$ from integral field spectroscopy is observationally expensive and the sample size is generally limited. As $S_{0.5}$ has the same form as the second moment of the velocity distribution, we use SAMI integral field spectroscopy to compare $S_{0.5}$ to the velocity dispersion $\sigma_{\mathbf{ap}}$ from measured aperture spectra, both by direct comparisons and in scaling relations. We find that both $S_{0.5}$ and $\sigma_{\mathbf{ap}}$ allow galaxies of all morphological types to be put onto the same scaling relation, using measurements of either gas or stellar kinematics. Moreover, the scatter about the mass scaling relation is comparable for $S_{0.5}$ and $\sigma_{\mathbf{ap}}$ at around 0.07-0.10 dex for SAMI galaxies.



Context:

With the advent of modern integral field spectroscopy (IFS) surveys, the $\log M_* - \log S_{0.5}$ scaling relation (where $S_{0.5} = \sqrt{0.5 \cdot V_{rot}^2 + \sigma^2}$) shows promising ability to bring galaxies of all morphologies onto the same scaling relation.

However, $S_{0.5}$ requires IFS data, which is observationally expensive and demanding. What we do have in bulk are single aperture spectra from fibre surveys such as SDSS and Taipan.

Can we match $S_{0.5}$ to $\sigma_{\mathbf{ap}}$ and unify galaxy scaling relations for Taipan?

Data:

The key parameters of the SAMI survey are as follows:

WAVELENGTH COVERAGE	370-570 nm	625-750 nm
SPECTRAL RESOLUTION	1750	4500
VELOCITY RESOLUTION	73 km/s	28 km/s
REDSHIFT RANGE	0.004 < z < 0.095	

Method:

We constructed the $S_{0.5}$ parameter from both gas & stellar kinematic measurements with pPXF based on SAMI survey data.

We constructed 3” diameter aperture spectra by binning the SAMI data cubes, and measured stellar and gas aperture velocity dispersion $\sigma_{\mathbf{ap}}$ using pPXF.
We compared $S_{0.5}$ and $\sigma_{\mathbf{ap}}$ directly (see above) and also constructed mass scaling relations (see figure at right).

Results:

1. $S_{0.5}$ and $\sigma_{\mathbf{ap}}$ are highly correlated, for both gas and stellar components; $\sigma_{\mathbf{ap}}$ slightly under-estimates $S_{0.5}$ for lower-mass galaxies.
2. Gas and stellar kinematic are more similar within 3” apertures than for $S_{0.5}$ estimate within 1 Re.
3. $S_{0.5}$ and $\sigma_{\mathbf{ap}}$ produce mass scaling relations with similar scatter, with RMS of ~0.07 dex for stars and ~0.10 dex for gas.
4. Gas scaling relations with $S_{0.5}$, $\sigma_{\mathbf{ap}}$ have similar slope/intercepts.