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Scaling relations in early-type galaxies from integral-field stellar kinematics

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Early-type galaxies (ETGs) satisfy a now classic scaling relation $R_{\rm e} \propto \sigma_{\rm e}^{1.2} I_{\rm e}^{-0.8}$, the Fundamental Plane (FP; Djorgovski & Davis 1987; Dressler et al. 1987), between their size, stellar velocity dispersion and mean surface brightness. A significant effort has been devoted in the past twenty years to try to understand why the coefficients of the relation are not the ones predicted by the virial theorem $R_{\rm e} \propto \sigma_{\rm e}^{2} I_{\rm e}^{-1}$.

Recent studies, using independent approaches from either (i) detailed dynamical models or (ii) strong galaxy lensing, point to a genuine variation of the mass-to-light ratio M/L in galaxies as the reason for nearly all the observed 'tilt' in the FP (e.g. Cappellari et al. 2006; Bolton et al. 2008). However these studies are limited by a small and biased sample or are restricted to only the most massive ETGs respectively.

We overcome both limitations by modeling the stellar dynamics, using axisymmetric Jeans anisotropic models (JAM; Cappellari 2008), for the K-band selected, volume-limited ATLAS^{3D} sample of 263 nearby ETGs, spanning a large range of masses and with $60 < \sigma_{\rm e} < 350$ km s^{-1}. A key for the project is the availability for all galaxies of high-quality integral-field kinematics observed with the SAURON spectrograph and detailed Multi-Gaussian Expansion (Emsellem et al. 1994) models of the photometry.

We confirm the genuine M/L variation and construct both the FP and the More FP (MFP; Bolton et al. 2007) for the ATLAS^{3D} sample, relating the mean surface density $\Sigma_{\rm e} \equiv I_{\rm e} \times (M/L)_{\rm JAM}$, $\sigma_{\rm e}$ and $R_{\rm e}$. Our MFP produces a relation as tight as the FP over the full mass range. We compare the global $(M/L)_{\rm JAM}$ variation among galaxies with predictions from two-SSP stellar population models and find that variations of both dark matter (or IMF) and population are required to explain the observations.

References

Bolton, A. S., et al. 2008, *ApJ*, 684, 248
Bolton, A.S., Burles, S., Treu, T., Koopmans, L.V.E., & Moustakas, L.A. 2007, *ApJ*, 665, L105
Cappellari, M., et al. 2006, *MNRAS*, 366, 1126
Cappellari, M. 2008, *MNRAS*, 390, 71
Djorgovski, S., & Davis, M. 1987, *ApJ*, 313, 59
Dressler, A., et al. 1987, *ApJ*, 313, 42
Emsellem, E., Monnet, G., & Bacon, R. 1994, *A&A*, 285, 723