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The SAURON Project - XIX. Optical and near-infrared scaling relations of nearby elliptical, lenticular and Sa galaxies

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[Abridged] We present ground-based MDM V-band and Spitzer/IRAC 3.6um-band photometric observations of the 72 representative galaxies of the SAURON Survey. In combination with the SAURON stellar velocity dispersion measured within an effective radius (se), this allows us to explore the location of our galaxies in the main scaling relations. We investigate the dependence of these relations on our recent kinematical classification of early-type galaxies (i.e. Slow/Fast Rotators) and the stellar populations. Slow Rotator and Fast Rotator E/S0 galaxies do not populate distinct locations in the scaling relations, although Slow Rotators display a smaller intrinsic scatter. Surprisingly, extremely young objects do not display the bluest (V-[3.6]) colours in our sample, as is usually the case in optical colours. This can be understood in the context of the large contribution of TP-AGB stars to the infrared, even for young populations, resulting in a very tight (V-[3.6]) - se relation that in turn allows us to define a strong correlation between metallicity and velocity dispersion. Many Sa galaxies appear to follow the Fundamental Plane defined by E/S0 galaxies. Galaxies that appear offset from the relations correspond mostly to objects with extremely young populations, with signs of on-going, extended star formation. We correct for this effect in the Fundamental Plane, by replacing luminosity with stellar mass using an estimate of the stellar mass-to-light ratio, so that all galaxies are part of a tight, single relation. The new estimated coefficients are consistent in both photometric bands and suggest that differences in stellar populations account for about half of the observed tilt with respect to the virial prediction. After these corrections, the Slow Rotator family shows almost no intrinsic scatter around the best-fit Fundamental Plane.

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