A Fundamental Plane for GAMA galaxies

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Abstract. A full appreciation of the role played by gas metallicity ($Z$), star-formation rate (SFR), and stellar mass ($M_*$) is fundamental to understanding how galaxies form and evolve. Using data from the SDSS–DR7 and the GAMA surveys we study the Fundamental Plane for star-forming galaxies. Our analysis allows us to confirm the existence of a Fundamental Plane, for which stellar mass=$f(Z,\text{SFR})$ in star-forming galaxies.

Keywords. galaxies: abundances — galaxies: fundamental parameters — stars: formation — galaxies: statistics

The existence of fundamental planes (FP) is a natural result of scaling relationships between important astrophysical properties. A FP was found by Lara-López \textit{et al.} (2010) in a three dimensional study of the $M_*$, gas metallicity, and SFR of SF galaxies using data from the SDSS-DR7. Lara-López \textit{et al.} (2010) showed that the $M_*-Z$, and $M_*-\text{SFR}$ relationships are particular cases of a more general relationship, a FP. This combination reduces the scatter significantly compared to any other pair of correlations. Using GAMA and SDSS star forming galaxies, we performed a principal component analysis (PCA) to identify the underlying dimensionality of the three observables. We find that the first two principal components account for 86\% and 12\% of the variance, which indicates that 98\% of our data can be explained in a 2 dimensional space (for a detailed explanation of this technique see Lara-López \textit{et al.} 2012, in preparation). The FP for GAMA and SDSS galaxies can be seen in Fig. 1. The $M_*-Z$, $M_*-\text{SFR}$, and $Z-\text{SFR}$ relationships are the projections of this 3D distribution. While $M_*$ correlates with both SFR and metallicity (the well known $M_*-Z$ and $M_*-\text{SFR}$ relationships), the SFR does not strongly correlate with metallicity, which means that this relation is close to the face-on view of the 3D distribution (see top left panel of Fig. 1).

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{fig1.png}
\caption{Projections of the 3D distribution formed by $M_*$, log(SFR), and $12+\text{log(O/H)}$ for GAMA and SDSS galaxies. The cube is rotated clockwise from the upper-left to the bottom-right panel. Grey and black dots show galaxies above and below the FP, respectively.}
\end{figure}

Reference