Using Hierarchical Bayesian Meta-Analysis to Improve Constraints on the Star Formation Rate and Total Stellar Mass of the Milky Way

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Due to both dust extinction and our inside-out perspective, determining the global properties of the Milky Way poses unique challenges. Here, we build on prior measurements of the Milky Way's stellar mass and star formation rate (SFR) using a hierarchical Bayesian (HB) analysis method in order to extract as much information as we can from a multitude of independent results. This technique is "hierarchical" in the sense that it allows us to fit for parameters that characterize the measurement process itself (e.g., how often measurements are accurately described by their nominal means and errors), while simultaneously fitting for the physical parameter of interest (e.g., the SFR) in a Bayesian framework similar to maximum likelihood methods. Our results are robust to a wide variety of assumptions about potential systematic errors or the nature of problems with error estimates in literature measurements. Ultimately, our analysis yields a SFR for the Galaxy of 1.65 ± 0.19 solar masses per year, a total stellar mass of $6.10 \pm 1.16 \times 10^{10}$ solar masses, and thus a specific star formation rate of $2.70 \pm 0.94 \times 10^{-11}$ yr^{-1}. Our results provide improved constraints on the global star formation history of the Milky Way, allowing us to more accurately determine how its properties compare to other galaxies.