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Measuring energy equipartition in Globular Clusters with dynamical models

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Introduction: The gravitational encounters occurring in Globular Clusters (GCs) drive the system toward energy equipartition and trigger other dynamical processes, that still require a self-consistent theoretical description. Internal kinematics observations show a partial degree of equipartition (Libralato et al. 2018, 2019, 2022; Watkins et al. 2022), confirming N-body predictions (Trenti & Van Der Marel 2013; Bianchini et al. 2016; Webb & Vesperini 2017; Pavlik & Vesperini 2021, 2022)

Method: Through a multi-mass dynamical model we estimate the energy equipartition degree in eight GCs. We constrain model parameters fitting the velocity dispersion dependence on stellar mass from HST proper motion data by Watkins et al. 2022, comparing with the fitting function by Bianchini et al. 2016, found from N-body simulations. An higher equipartition degree is obtained for a more advanced dynamical state, identified by the parameter Φ_0, a measure of the gravitational potential well. We discuss its relation with the equipartition mass $m_{\rm eq}$, in the Bianchini fitting function, as well as other structural properties. We also find that a constrain to $m_{\rm eq}$ obtained by fitting proper motion data suffers projection and shell selection effects, underestimating the level of equipartition. On the contrary, our equilibrium configuration predicts the equipartition degree at any radial coordinate, without suffering such effects.

Conclusions: With the help of our model, we plan to broad the analysis of the equipartition degree in GCs to obtain a more statistically significant sample for the structural parameters. Furthermore, we can perform N-body simulations setting initial conditions from our model, exploring an initial degree of equipartition (and mass segregation) as well as differences in the kinematical properties of Multiple Populations, an highly debated topic in the field. Indeed, their initial properties and their impact in the dynamical evolution of GCs are still widely unclear and require further investigation.

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