Recent observations have confirmed the flattening of the radial velocity dispersion profiles for stars in various nearby globular clusters. Under Newtonian gravity, this is explained by invoking tidal heating from the overall Milky Way potential on the outer more loosely bound stars. From the point of view of modified gravity theories, such an outer flattening is expected on crossing the critical acceleration threshold $a_0$, beyond which, a transition to MONDian dynamics is expected. From an empirical point of view, we determine Newtonian tidal radii using masses accurately calculated through stellar population modeling, and hence independent of any dynamical assumptions for a sample of globular clusters. Crucially, we find that the asymptotic values of the velocity dispersion profiles scale with the fourth root of the total masses in accordance with the galactic Tully-Fisher relation. Also, in all cases, Newtonian tidal radii at perigalacticon are larger than the radii at which the flattening in the velocity dispersion profiles occurs, which correlate with the radii where the $a_0$ threshold is crossed, as expected under modified gravity scenarios.

**TULLY-FISHER RELATION IN GLOBULAR CLUSTERS**

The quantities plotted here are velocity dispersion values in the outskirts of GCs in Scarpa’s sample and Lane’s sample (Lane et al. 2009, 2010a, b, 2011) and the total masses as inferred from total luminosities and models of their observed stellar population. The data are consistent with the generic modified gravity prediction of $\sigma^4 \propto M$, lending credibility to the interpretation of these measurements as evidence for modifications in the law of gravity.

**EXCLUDING NEWTONIAN TIDAL HEATING**

In this figure we show values of the radius beyond which the dispersion velocity profile becomes flat for our clusters ($R_f$), plotted against their corresponding Newtonian tidal radii values ($R_T$) from accurate estimates of the Newtonian tidal radii in Allen et al. (2006) and Allen et al. (2008). In that study, both a full 3D axisymmetric Newtonian mass model for the Milky Way and a model incorporating a galactic bar were used to compute precise orbits for a large sample of globular clusters. The solid line shows a $R_f = R_T$ relation, it is obvious from the figure that the onset of the flat velocity dispersion regime occurs at radii substantially smaller than the Newtonian tidal radii for most of the GCs in our sample.

**CONCLUSIONS**

- For Galactic GCs where the flattening of the radial velocity dispersion profiles is observed, spherically symmetric equilibrium models can be constructed using a MONDian force law, which naturally satisfies all observational constraints available.
- We show that the asymptotic values of the measured velocity dispersion profiles, $\sigma_0$, and total masses for GCs studied, $M$, are consistent with the generic modified gravity prediction for a scaling $\sigma_0^4 \propto M$.
- For our GCs, Newtonian tidal radii are larger than the radii where $\sigma(R)$ flattens, making the explanation under Newtonian hypothesis suspect, on the other hand, the radius where $\sigma(R)$ flattens, and the point where average stellar accelerations fall below the $a_0$ threshold correlate, which is consistent with a qualitative chance in gravity in the low-acceleration regime.

**OTHERS MANIFESTATIONS OF MONDian GRAVITY**

- Wide binaries: for systems with $1M_\odot$, at separations beyond 7000AU acceleration is of order $a_0$ and observed relative velocities become constant.
- Elliptical galaxy NGC4649: under Newtonian gravity a 40% of dark matter content is necessary to explain the flattening of velocity dispersion profile of this galaxy. From the MONDian gravity perspective this flattening is expected and obviously explained.
- For our GCs, Newtonian tidal radii are larger than the radii where $\sigma(R)$ flattens, making the explanation under Newtonian hypothesis suspect, on the other hand, the radius where $\sigma(R)$ flattens, and the point where average stellar accelerations fall below the $a_0$ threshold correlate, which is consistent with a qualitative chance in gravity in the low-acceleration regime.

**INTRODUCTION**

One generic prediction of modified gravity theories is that as accelerations fall below $a_0 \approx \frac{1}{2} \times 10^{-13} m/s^2$, a transition should occur away from Newtonian gravity. This modified regime will be characterized by equilibrium velocities which scale with mass as $V_0 \propto M$. The recent studies by Scarpa et al. (2007a,b, 2010, 2011) find precisely that flattening in the velocity dispersion profiles occur away from Newtonian gravity. This flattening is expected on crossing the critical acceleration threshold $a_0$, lending credibility to the interpretation of this measurements as evidence for modifications in the law of gravity.

**MODELING OBSERVED GLOBULAR CLUSTERS**

We construct fully self-consistent dynamical models for Galactic GCs using the modified Newtonian force law formulation of Mendoza et al. (2011), which tends asymptotically to $f = \sqrt{M(\rho)} \propto \rho$. The modeled density profiles are calibrated to match observed surface brightness, projected velocity dispersion radial profiles, and total masses inferred through a careful single stellar population modeling of the GCs in question.

The quantities plotted here are velocity dispersion values in the outskirts of GCs in Scarpa’s sample and Lane’s sample (Lane et al. 2009, 2010a, b, 2011) and the total masses as inferred from total luminosities and models of their observed stellar population. The data are consistent with the generic modified gravity prediction of $\sigma^4 \propto M$, lending credibility to the interpretation of these measurements as evidence for modifications in the law of gravity.

**Abstract**

Recent observations have confirmed the flattening of the radial velocity dispersion profiles for stars in various nearby globular clusters. Under Newtonian gravity, this is explained by invoking tidal heating from the overall Milky Way potential on the outer more loosely bound stars. From the point of view of modified gravity theories, such an outer flattening is expected on crossing the critical acceleration threshold $a_0$, beyond which, a transition to MONDian dynamics is expected. From an empirical point of view, we determine Newtonian tidal radii using masses accurately calculated through stellar population modeling, and hence independent of any dynamical assumptions for a sample of globular clusters. Crucially, we find that the asymptotic values of the velocity dispersion profiles scale with the fourth root of the total masses in accordance with the galactic Tully-Fisher relation. Also, in all cases, Newtonian tidal radii at perigalacticon are larger than the radii at which the flattening in the velocity dispersion profiles occurs, which correlate with the radii where the $a_0$ threshold is crossed, as expected under modified gravity scenarios.