Explaining Imbalance of Tidally Ejected Stars from Open Stars Clusters without MOND

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November 19, 2022

Abstract:

Results from a recent paper, and accompanying popular articles, have argued that the observed asymmetry in the numbers, and distributions, of stars tidally ejected in front, versus at the tail of open stars clusters, would favor the MOND theory (Modified Newtonian dynamics), over Newton gravity, and hence General Relativity (GR).

This paper disputes such conclusions by showing that the observed asymmetry can equally well be qualitatively explained with multi-fold mechanisms, which propose that macroscopic entanglements between real particles are behind the effects of Dark Matter, and that entanglements of virtual particles explain gravity. This is captured by the E/G conjecture.

Considering other similar results, and the fact that we encounter hints of multi-folds in our real universe, in particular with GR at Planck scales, we believe that the explanation proposed in our paper is another viable alternative to relying on MOND. As the multi-fold theory recovers GR, our approach does not require modifying GR, with ideas like MOND. In such a universe we can justify why more starts are ejected in the front than at the tail of galaxy clusters, where the galaxies tends to dilute.

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1. Introduction

In a multi-fold universe [1,8-10,22,*128,134,135,148*], gravity emerges from entanglement through the multi-fold mechanisms. As a result, gravity-like effects appear in between entangled particles [1,24,25], whether they be real or virtual. Long range, massless gravity results from entanglement of massless virtual particles [1,26]. Entanglement of massive virtual particles leads to massive gravity contributions at very smalls scales [1,27]. It is at the base of the E/G Conjecture [24], and the main characteristics of the multi-fold theory [22]. Multi-folds mechanisms also result in a spacetime that is discrete, with a (2D) random walk fractal structure, and non-commutative geometry, which is Lorentz invariant, and where spacetime nodes and particles can be modeled with microscopic black holes [1,16,27-32]. All these recover General Relativity (GR) at large scales, and semi-classical models remain valid till smaller scale than usually expected. Gravity can therefore be added to the Standard Model (SM) resulting into what we define as SM_G: the SM with gravity effects non-negligible at its scales. This can contribute to resolving several open issues with the Standard Model, and the Standard Cosmological model (ΛCDM) [81] without new Physics other than the addition of gravity [1,4-40,46-69,73-*148*].

Note added on December 20, 20223: In this paper, references in italic were added on December 20, 2023.

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Cite as: Stephane H. Maes, (2022), "Explaining Imbalance of Tidally Ejected Stars from Open Stars Clusters Without MOND", https://doi.org/10.5281/zenodo.10421124, https://shmaesphysics.wordpress.com/2022/11/19/explaining-imbalance-of-tidally-ejected-stars-from-open-stars-clusters-without-mond/, November 19, 2022.

Among the multi-fold SM_G discoveries, the apparition of always in-flight, and hence non-interacting, right-handed neutrinos, coupled to the Higgs boson, is quite notable. It is supposedly always around the right-handed neutrinos, due to chirality flips by gravity of the massless Weyl fermions [1,30,53,57,59,61,94,*113*], induced by 7D space time matter induction and scattering models, and hidden behind the Higgs boson or field at the entry, exit and mapping points of the multi-folds [1,30,94,*138*]. Massless Higgs bosons are modeled as minimal microscopic black holes mark concretized spacetime locations. They can condensate into Dirac Kerr-Newman soliton Qballs to produce massive and charged particles [1,4], thereby providing a microscopic explanation for a Higgs driven inflation, the electroweak symmetry breaking, the Higgs mechanism, the mass acquisition, and the chirality of fermions and spacetime; all resulting from the multi-fold gravity electroweak symmetry breaking [1,4,23,27,28,31,32,58,60-62,69,*143*]. Above the gravity electroweak symmetry breaking, massless particles result from random walk patterns dictated by the 7D space time matter induction and scattering. The multi-fold theory has also concrete implications on New Physics like supersymmetry, superstrings, M-theory and Loop Quantum Gravity (LQG): they are not physical [1,8-21,84,*131,141*].

Multi-folds are encountered in GR, at Planck scales [5,6] and in Quantum Mechanics[2] (QM) if different suitable quantum reference frames (QRFs) are to be equivalent relatively to entangled, coherent or correlated systems [7]. This shows that GR and QM are different facets of something that they cannot well model by themselves: multi-folds.

The paper starts with an overview of the multifold dark matter mechanisms [1,24,25,35], and past papers discussing qualitative alignments with observations and simulations [1,36-40,47], including several cases that were presented as arguments to favor MOND (See [41,42] and reference therein) over GR. Our past results indicate that MOND was not the only explanation, and that indeed multi-fold dark matter effects were as suitable. Our paper aims at reaching a similar conclusion here.

We summarize results obtained in [43], that seem to indicate, again, that MOND would be the preferred model at the large scales of galaxies and above; arguments relished by popular science articles [44,45]. In [46], we commented that such a conclusion may not be warranted.

The paper shows how it is possible to qualitatively account for the reported asymmetric distributions of stars tidally ejected from galaxies.

Considering results as in [6], and our answers to so many open issues with the SM_G as discussed for example in [1,4-40,46-69,73-*148*], we can then argue that these conclusions can apply to our real universe.

2. Multi-Fold explanation for Dark Matter

[1,35] recover automatically dark matter with its model of attractive effective potential appearing between physical (real) entangled systems [25], at the difference of the virtual entangled particles which already account for gravity [1,24-26,*134,135,148*].

Accordingly, emitted massless (or quasi massless, like neutrinos) particles are entangled in pairs, or with their sources or intermediate systems. It account for extra gravity like attraction towards the geometrical center of the entangled systems and / or halos around galaxies. It is illustrated in figure 1 (from [35]).

[2] Standing in for Quantum Physics in general.

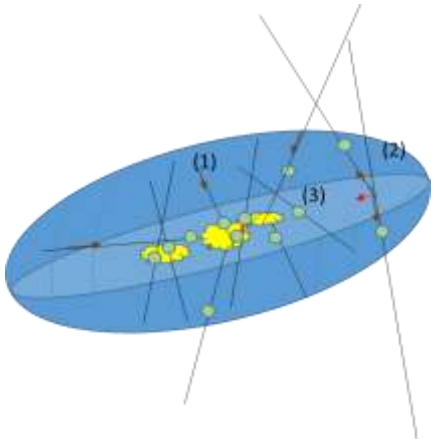

Figure 1: It illustrates how the different entanglements cases, discussed in the text, appear as dark matter with attraction towards the galaxy center and the centers of mass in the galaxy, or in halos. Green circles represent the center of masses. (Reused from [1,35]).

[35] (see its figure 2) explains that it can also account for globular galaxies where no significant dark matter is detected.

[25,36,38] provide additional analyses of astronomical observations that challenge conventional dark matter theories. It shows that we can account for all the reported behaviors, and don't need MOND for that.

[37,40] provides other examples where the multi-fold dark matter effects match simulations, results and/or observations. In these cases, simulated loss of dark matter in galaxy close encounters, excess of disk galaxies vs. what is conventionally predicted, is explained by less galaxy-to-galaxy attraction due to multi-fold dark matter effects, and dark matter halo expansion with time. With multi-fold dark matter effects, MOND [41,42] are no longer "the only alternative explanation" to such conventional dark matter challenges.

3. Multi-fold gravity

[1] describes how, in multi-fold universes, gravity results from the multi-fold mechanisms between virtual particles radiated[3] by sources of energy, e.g., mass. Such a mechanism recovers GR, and Newtown gravity as approximation, with massless gravity at large, and semi classical scales, and massless plus massive gravity at the very short range of massive particle [1,6,26].

Multi-fold gravity is also at the basis of SM_G, a standard model with gravity, where the gravity effects are not negligible at the scales of the SM: effects increase as the scale reduces, and the massive particle ranges start to roughly match the SM scales, so massive effects can also start to contribute.

4. The latest, among many, push for MOND

[3] Proportionally to the mass or energy content of the source.

According to a recent paper [43], and associated popular science articles like [44,45], there is an observed asymmetry of the number of stars ejected in the leading versus the trailing tails of five open clusters of gas forming stars. Note that's only five clusters, probably not enough to be truly conclusive. [43] analyses open clusters of stars and gas, and tidal ejection, which is due to interactions with other stars in the cluster and tidal effects.

This asymmetry is counterintuitive for GR based models.

In [43], the authors rather focus on Newton gravity, but we know that GR is well approximated at such scales by Newton gravity. They argue that their reported observations can be well justified, if one assumes that MOND (Modified gravity [41,42]) reigns instead of conventional GR/Newton gravity. The argument goes as follows: MOND predicts a weakening of gravity as acceleration increases. Figure 2, illustrates it for a simple open cluster model. The acceleration felt in the front (leading tail) is smaller than in the (trailing tail). Therefore, per the MOND theory, the stars in the trailing tail feel a stronger attraction back towards the cluster, and stronger tidal effects, than the ones in the leading tail.

A priori, GR, or Newtown gravity, can't justify such an observed statistical behavior.

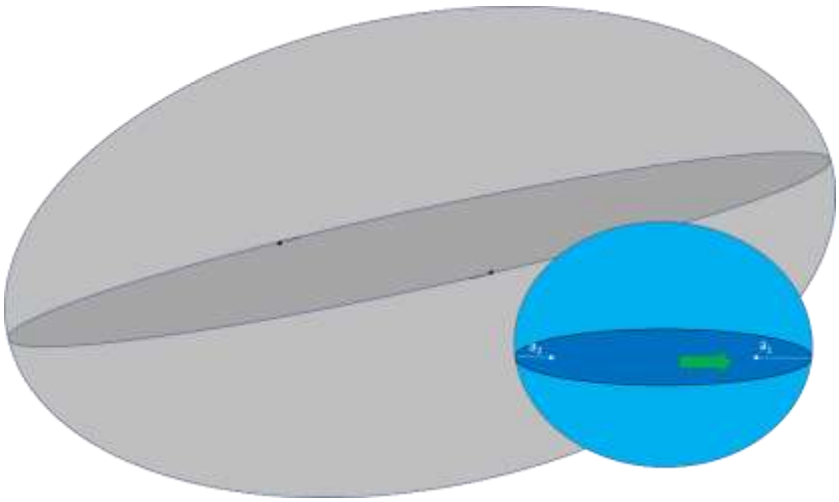

Figure 2: Consider the blue open cluster of stars and gas. It may or may not also be influenced by (a) galaxy(ies), in grey, to recover situations as in [70]. The direction of motion of the cluster is indicated by the green arrow. As the cluster content catches up with the head of the cluster, the attraction effect is expected to increase on the leading side and decrease on the tailing end. Going back to basic Newtown law, it means that the acceleration a_1 is larger than the acceleration a_2. With MOND, the gravity effects would therefore be smaller near the head, while the stars are pulled together by the movement which increases the chances of interactions leading to ejection. In the back, we have stars moving away towards the center and front, and therefore less likely to interact till there. The MOND is busy preventing ejections, pulling back in more strongly any potentially ejected star candidates. As a result we would get stronger tidal effect in front and more possibilities of ejection, consistent with [43,44,45]. However, the cluster expands via it rear and will eventually melt away.

Per figure 2, stars in the front are getting denser in front, which means more opportunity for interaction that result in ejection, and gravity is weaker in front which encourages ejection from the cluster. In the back, gravity pull starts towards center and front where the previous reasoning applies. As a result, the back has less interaction and rather leaks gas or expands the cluster consistent with [43,70].

5. Open clusters of stars in a multi-fold universe

Let us repeat the analysis, and now consider the model of figure 2 in a multi-fold universe. Because of the movement of the clusters, and following the multi-fold mechanisms from [1,*a133-135,148*], including dynamic effects [*109*], the result is that:

- In front (leading tail), gravity pulls consistently towards the center of the cluster because the center of mass of multi-fold associated to pairs of particles and anti-particles (as well as dark matter effects for real particles) moves towards the center, while the content also catches up. It overall increases the chances of interactions resulting in ejection in the front from the cluster.
- In the trailing tail, the opposite occurs and the geometric centers of mass dilute, which results in attraction of the content towards the front and center and towards the end. It reduces the amount of candidate interactions that can produce ejection. Any ejection is still dominantly attracted towards the center and front, which balance contributions from the end, reducing the opportunities to eject from the cluster. Again, the effects expand the clusters (star and gas) but not with ejection [43,70].

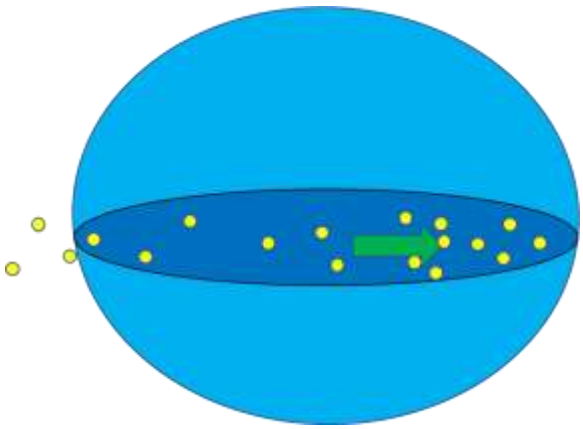

Figure 3: Consider the blue open cluster of stars and gas. Yellow dots represents how the geometrical center (entry points in [1]) of the multi-folds. They are more strongly pulled in towards the center on the leading side and less strongly towards the center and front in the trailing end where it can expand. Yet gravity effects reduces near the head itself and increase in back. As a result, there is an asymmetry that will increase the "interactions" between cluster elements in the front, and reduce it in the trail, even if its pulls open the cluster: opportunities to have interactions resulting into ejection are larger in front than in the back, and ejection from the cluster are easier in the front, while the back dilutes.

In figure 3 and the associated reasoning, we combine effects of multi-fold dark matter and gravity: the involved multi-fold geometrical centers can be both for multi-folds between entangled virtually particles (multi-fold gravity)[1], or between entangled real particles (multi-fold dark matter effects) [35].

6. Conclusions

The paper shows that MOND is not the only possible explanation for the observed asymmetry in the distribution of stars tidally ejected from open clusters.

The fact that multi-fold mechanisms lead to similar qualitative behaviors should again position it as an alternative to MOND, deserving at the minimum the same considerations, especially as we have been able, time and time again, to explain with multi-folds what some claimed that only MOND can explain. The multi-fold theory has the big advantage that it actually does not modify GR, or the Newton gravity approximations. It rather explains additional phenomena, like dark matter, dark energy, or in this case the effect of the dynamics on the overall gravity effects, analogous for example to frame dragging effects of GR [*109*].

This is also to be added to all the other cases where we have shown that multi-fold can explain observations as well as MOND, without the problematic tuning issues that are very well summarized in [71,72].

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