Stability of Globular Clusters

by Paul R. Gerber

Gerber Molecular Design, Margaretenweg 14, CH-4310 Rheinfelden

Email: Paul.Gerber@moloc.ch

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Abstract

It is shown that an isolated star cluster is a stable configuration. Separation of a single star from all the others would cost an amount of energy, that grows with the logarithm of its distance from the remaining rest. This is in contrast to the general opinion that such a cluster would eventually decay into small units. However, this conventional view is hardly ever mentioned, considering the fact that clusters have been found that are older than the (awkwardly supposed) age of the universe.

Definitions

We start with a list of definitions for the relevant quantities occurring in this note (compare corresponding note on the stability of the Coma cluster of galaxies [1]).

1. Speed unit is the speed of light (c = 1).
2. β = angular width of a star as seen from a typical neighbor star, depends on population density
3. v = difference of perpendicular speed component of typical neighbors (i.e. star - observer)
4. v_c = critical value of v, above which the observer can only be hit by either graviton or anti-graviton (which must be emitted as a pair); depends on typical population density
5. φ = fraction of stars moving sufficiently directly towards elected star such that graviton and anti-graviton from one of them hit the elected star.
6. σ = fraction of unit sphere covered by one neibor star.
7. $p = \varphi * \sigma * N$, = probability of coincidental hit by graviton and anti-graviton of two different globular stars, where N is the number of stars in the cluster.

Previous Remarks and Comparison with New Statement

In a earlier consideration on the Coma cluster of galaxies [1,2] we have concluded that the various galaxies in the cluster attract each other by forces that decay with distance according to a 1/r law, where

r is the distance of a pair of galaxies. A consequence of this result is that for an isolated cluster all galaxies are bound together such that the separation of one galaxy would cost an amount of energy that grows like the logarithm of its increasing distance from the rest.
In the current note we present a corresponding consideration for a globular cluster (GC for short) of stars, showing that separation of a single star from an isolated cluster would also need an amount of energy growing with the logarithm of its increasing distance from the cluster. This is in contrast to the general believe that star clusters would eventually decay by continuous separation of single stars or small units with “escape velocities”. The error of this opinion has become obvious by the measurement of cluster ages [3] which yielded times (up to 16 Gyr) that exceed the (wrongly [4,5]) supposed age of the universe (of 13.8 Gyr)[6].
Our present considerations parallel the above mentioned treatment of the Coma-Cluster [1] in principle. However, the corresponding values of the relevant quantities differ substantially for the two situations, as recorded in the following list:

Ad 2: In the center of a globular cluster the stars have a typical average neibor distance of 0.1 pc (parsec) which yields a value β_{center} of 5.28 10^{-7}. This is 10 times the value found in the bulge of a galaxy. Thus, nearest stars in the center of a GC are about 10 times closer to each other than nearest stars in the central bulge of a galaxy.

Ad 3: The critical difference of the perpendicular speed component of neibors is v_{cb} = 200 m/sec, ten times the value for stars in the central bulge of a galaxy (compare [1]).
Typical velocities of cental stars are ~ 15 km/sec ~ 100 v_{cb} .

Ad 5: It follows that the fraction of stars that move sufficiently directly towards an elected star is still pretty small, namely
$\varphi = 2*10^{-4}$,
but considerably larger than the corresponding quantity in the case of a galaxy bulge ($2*10^{-8}$).

Ad 6: The fraction of the unit sphere covered by a typical central neibor is
$\sigma = .5*\pi*\beta_{center}{}^2/(4\pi) = 3*10^{-14}$,
roughly 100 times larger than the corresponding value in a galaxy bulge.

Ad 7: Finally, assuming $N = 10^6$, the probability of a coincidental hit (graviton and anti-graviton from two different globular stars) is still only $p = 6*10^{-12}$, (even ten times smaller than in the case of galaxy clusters [1]) which makes a coincidental hit extremely improbable.

Conclusion

An isolated Globular Star Cluster is a stable configuration that cannot decay by itself. The amount of energy needed to separate a single star increases with the logarithm of its distance from the rest, in total analogy to the case of galaxy clusters [1]. The only way to reduce a cluster is to loose stars to a neiboring cluster or galaxy. This is in contrast to the general opinion which, however, considering the actual cluster ages, is not anymore stressed, nor even mentioned in official reports [7,8].

References

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