Black Hole Clusters: The Dark Matter

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Abstract

Galactic black holes were created during the Big Bang. As such, they were available for clustering in the early Universe. This paper describes the role these clusters could play in explaining dark matter.

1. Introduction

Apart from the disk of a spiral galaxy, every bound stellar system in the Universe is a cluster. This broad statement refers to the random motion of stars in the core of spiral galaxies, in elliptical galaxies, in dwarf galaxies and star clusters, as well as in the recently discovered dark star clusters and dark galaxies. Moreover, it refers to the random motion of galaxies and hot (x-ray emitting) gas in galactic clusters. With the exception of spiral galaxies, it is natural to think that a black hole cluster is responsible for the dark matter in each of these structures. (A previous article treats the missing mass of a spiral galaxy [1]. Suffice it to say that there is no evidence of a large black hole cluster in the Milky Way.)

A galactic black hole is a neutral gas of electrons and positrons [2]. The smaller masses—up to 3–4 x 10^6 $M_\odot$—are supported against gravity by electron degeneracy pressure. Larger masses are supported by ideal gas and radiation pressure. To date, the smallest mass which has been observed is 5 x 10^4 $M_\odot$, while the largest is 2 x 10^{10} $M_\odot$. These values correspond with the predictions of the electron-positron model. The presence of positrons shows that these black holes must have formed during the Big Bang. Thus, black hole clusters are to be expected in the very early Universe.

2. Dark Matter

It is generally believed that the early Universe was populated by a great many small galaxies. These galaxies did not possess sufficient hydrogen gas to ignite the black hole of a quasar. It would be a billion years or more before quasars made their appearance. Similarly, a black hole cluster of mass 10^{10}–10^{12} $M_\odot$ would slowly gather hydrogen gas from the intergalactic medium. A loose cluster of 10^3–10^5 black holes provides a gravitational potential which is spatially uniform, when compared with that of a quasar. Within this cluster, one can imagine the accumulation and eventual collapse of hydrogen gas into the protostars of an elliptical galaxy. The uniformity in the stellar population (all low-mass stars) argues for such an in situ process. In the above scenario, the black holes remain as dark matter. They also serve to heat the large volume of hot (10^7 K) gas, which now surrounds all elliptical galaxies. It is found that the larger galaxies have a greater proportion of dark matter. This is consistent with the observation that black holes tend to inhibit star formation. An extreme example is that of a dark galaxy, in which the black hole cluster is, perhaps, too concentrated to allow any significant production of stars.

The evolution of dwarf galaxies (10^7–$10^9\,M_\odot$) appears to have begun with the merger of primitive galaxies. As the small galaxies merged, their black holes formed a cluster in the dwarf galaxy. The violence of the mergers caused a period of rapid star formation. This coincided with the quasar period, which was also violent and active. It is thought that the dwarfs were eventually stripped of their stars and gas by the larger spiral and elliptical galaxies. They now remain as satellite galaxies devoid of gas, with a dark matter black hole cluster.

A very large cluster of black holes (10^{14}–$10^{15}\,M_\odot$) would preclude the formation of stars. However, it could provide the gravitational anchor for a cluster of galaxies. A galactic cluster harbors a vast quantity of extremely hot (10^8 K) gas, with an x-ray energy flux of 10^{43}–10^{45} ergs s^{-1}. The black hole cluster could readily sustain this flux for tens of billions of years.

Finally, there are the recently discovered dark star clusters. Black holes of mass $10^4\,M_\odot$ are rare, and so one would not expect to find dark matter in the small star clusters of the Milky Way. However, dark matter has been observed in more massive star clusters, which may contain a number of small black holes.

3. Conclusion

The narrative presented here is meant to be plausible. Regardless of the exact course of historical events, the experimental facts remain. The facts clearly call for an additional mass, in a wide variety of stellar structures. This work demonstrates that a black hole cluster can account for the additional mass in each one of the structures.

References

[1] K. Dalton, "The Missing Mass of the Milky Way Galaxy", *Hadronic J.* **36(4)**, 499 (2013). Also, https://arxiv.org/abs/0905.3595

[2] K. Dalton, "The Galactic Black Hole", *Hadronic J.* **37(2)**, 241 (2014) Also, http://vixra.org/abs/1404.0067