MASSIVE BLACK HOLES IN GALACTIC HALOS?

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We consider the idea that galaxy halos are composed of massive black holes, as a possible resolution of two problems: the composition of dark halos, and the heating of stellar disks. Scattering of disk stars by halo black holes with mass M_H, velocity dispersion σ_H and number density n_H causes the stellar velocity dispersion to increase with time t as $\sigma \approx (Dt)^{1/2}$ for t large, where $D \propto n_H M^2_H \ln \Lambda/\sigma_H$, and $\ln \Lambda$ is the Coulomb logarithm. This time-dependence is in good agreement with observations, as is the prediction for the axial ratios of the velocity ellipsoid $\sigma_u : \sigma_v : \sigma_w$. To account for the magnitude of the disk velocity dispersion in the solar neighbourhood, we require $M_H \approx 2\times10^6 M_\odot$. The stellar distribution function is predicted to be approximately isothermal at low epicyclic energies, in the Fokker-Planck regime in which the effect of the many distant, weak encounters dominates, but with a power-law tail at high energies produced by the relatively rare close encounters. This tail has the form $N(E) \propto E^{-2}$, where E is the horizontal or vertical epicyclic energy, and N(E) is the number of stars per unit area of the disk, per unit E. The fraction of stars in this power-law tail depends only on the value of $\ln \Lambda$, and is about 1% for typical values. This provides a possible explanation for the high velocity A stars found in the solar neighbourhood. This disk heating mechanism can also account for the approximate constancy of the disk scaleheight with radius that is observed in other spiral galaxies, although this does not result as naturally as the other properties.

We have calculated the effects of dynamical friction on the black holes, and find that ~100-1000 should have spiralled into the Galactic center over the life of the Galaxy. However, gravitational three-body interactions are likely to be effective in ejecting black holes from the center by the slingshot effect, so that at any given time there will probably be no more than two black holes at the center. Thus we naturally account for the compact object postulated to be at the center of the Galaxy by some observers. We have calculated the effects of gravitational lensing by the black holes, and find that they are probably consistent with observational limits. Approximately 1% of sources at redshift $z \approx 1$ will be significantly lensed, with typical image splittings of several milliarcsec, which should be detectable by VLBI. We have also considered the radiation emitted by the black holes as they accrete gas from the interstellar medium, which should make some of them very luninous. The absence of clear evidence for accreting black holes may pose a problem for the scenario.

REFERENCE

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