R46a Bar Dissolution Induced by Massive Central Black Holes

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Recent observations have revealed that most, if not all, large galaxies harbor massive central black holes (BHs), whose masses range from $\sim 10^6 M_\odot$ to $\sim 10^{9.5} M_\odot$. Previous studies have shown that such large BH masses can dissolve a barred structure in the disk. However, the required mass for bar destruction within a Hubble time is at least about 4 - 5% of the disk mass, and it corresponds to $\sim 10^{9.5} M_\odot$ when scaled to a typical disk galaxy with a mass $\sim 10^{11} M_\odot$. If this mass would only be attributed to a central BH, the BH mass needed to destroy bars exceeds the largest BH masses derived observationally in spirals, which leads to the conclusion that bar destruction by central BHs could not occur in the real universe.

We reexamine this bar dissolution problem for an infinitesimally thin exponential disk using a self-consistent field method in which no softening length is included. In particular, we pay attention to the characteristic properties of bar-dissolved galaxies as well as the minimum required BH mass for bar destruction.

We have found that central BHs should be at least as massive as 0.5% of the disk mass to dissolve bars. This mass scale corresponds to $10^{8.5} M_\odot$ when scaled to values appropriate for the Milky Way, and is marginally smaller than a supposed BH mass of $\sim 10^9 M_\odot$ for an Sa galaxy NGC 4594. Therefore, bars cannot be destructed so frequently by this process, but this phenomenon could occur in the real universe. We show that bar-dissolved galaxies have a large disk scale length and very large radial velocity dispersions, which could be used to discriminate between genuine unbarred and bar-dissolved galaxies.