Supermassive Black Holes and the Evolution of Galaxies.

This week's paper choice came about from the fact that Sandy Faber is visiting this week, who has done a lot of work on MBH, and the paper has some what to do with structure if you read the paper to the end.

The paper starts off stating general facts about black holes such as they are predicted by GR and that "black holes were implicated as the powerhouses for quasars and stellar-mass black holes were touted as the engines for many galactic X-ray sources". It goes on to talk about the even horizon, that we can not physically see it but from the mass relation Equation it can been verified that Massive Dark Objects, which are most likely Massive Black Holes are at the centers of galaxies.

There are two different kinds of Black Holes; there are extremely small ones which are categorized as stellar mass black holes and the extremely large supermassive black holes, it is a little odd that there isn't really anything in between the two. Technically there are intermediate and micro black holes but we actually don't are about anything but the supermassive black holes. It is thought that active galactic nuclei and quasars are powered by accretion from supermassive black holes. The next part of the paper is just a description on quasars. Since this is our 3rd paper dealing with quasars we should all understand this section. An interesting fact was that MBH lie at the center of galaxies because of dynamical friction drags then to the bottom of the potential well.

The 2nd section of the paper deals with dynamical evidence for massive black holes. It talks about the case with galaxy M87 and that it seemed but failed to show that the center was a black hole. Years later they where able to show that the Andromeda galaxy and its satellite galaxy had MDOs in the center. Later with better observational evidence by the HST it was found M87 had a MDO as well. It goes on to about ways to prove and improve finding of MDOs at the centers of galaxies.

Section 3 basically deals with the correlation between black holes and host spheroid luminosity. The main focus of this section can be seen in figure one where bulge luminosity is plotted against the mass of the MDO. There exists more available data but it is not yet verified. This section is nicely summed up in the last paragraph

"Our view of these observational results, largely developed over the past decade, is

as follows: (i) MBHs are a normal feature of the central regions of bright galaxies,

particularly those with spheroids; (ii) their masses scale in rough proportion to

host–galaxy spheroid mass; and (iii) the total mass density in black holes is broadly

consistent with the mass–equivalent energy density in the quasar light background.

We therefore believe that the black hole fossils of the quasar era have been found."

The 4th section leads in wit the era of quasars that take place at a red shift of about 3. So we are back into the history of the universe. So it seems necessary that MBH must have formed before the era of quasars. This can be seen in figure 2. This all comes down to the fact that the supermassive black holes formed before the galaxies. This works with the model of the history of the universe as it places star formation after the spheroid part of the galaxy collapses. Quasars seem to die out at a red-shift of 2; this could be accounted for due to a loss of fuel/gas. To take a measure of these MBH fossils must be identified with quasars to create a specific relation. To do this they need to assume that the radiation pressure balances the gravitational force "Eddington Luminosity". This Luminosity is extremely large. The next part of this I really don't understand. I think it is trying to resolve the extreme luminosity with the luminosity of quasars not matching up. Anyway they make a correlation that galaxies with pre-existing MBH will merge and toss stars from out the center of the galaxy. When observed brighter galaxies have less dense cores.

The final section talks about how to find evidence of MBH in the center of galaxies. The first relating to the case where the black hole is less than 10^8 solar masses, that stars will become partly striped instead of being swallowed whole. This produces a flare which lasts a relatively short time. It is also possible to find an emission spectrum that matches that of an accretion disk theoretically, this might have already occurred with NGC 1097. The final way to detect these supermassive black holes is by diction of gravity waves that would have been produced during mergers of galaxies. These events are hard to detect but LISA has the capability.