Host galaxies and environments of compact extragalactic radio sources
Labiano Ortega, Alvaro

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When we look up to the sky in a clear night, we can see stars, planets, comets, asteroids, clouds of dust and gas, and many other sorts of astronomical objects. Most of these, like the Sun and the Earth, live in big systems called galaxies. A galaxy is a massive system of stars, gas, and dust, together with planets and smaller bodies, bound together gravitationally (Figure 1). There are billions of galaxies.

This thesis deals with a special type of galaxies called radio galaxies, a sub-type of active galaxies. An active galaxy is one where the nucleus itself emits as much energy as (or even more than) the rest of the galaxy. They are said to have an Active Galactic Nucleus, or AGN. This energy is thought to be created by matter falling into an extremely massive black hole (1,000,000,000 times the mass of the Sun, inside a sphere of a few kilometers) on the center of the galaxy.

It is thought that the in-falling matter forms a disk around the black hole: the accretion disk. In fact, it is this glowing rotating disk that is producing the large amounts of energy we detect (from radio wavelengths to X-rays!). This disk is believed to widen up as we move away from the center forming a torus around the nucleus, in the same plane of the disk. Due to this torus, if we observe the AGN sideways (from the bottom right corner in the picture on the cover), we will not see the nucleus. In this case, we call the AGN a Seyfert 2 or radio galaxy, depending on how much light is emitted in radio and optical wavelengths.

If a particle manages to fly by the black hole (and not fall into it), it may get trapped in the black hole magnetic field. Depending on the velocity of the particle, the magnetic field will push it down to the black hole or accelerate it outwards in a very collimated flow or jet (the yellow lines on the cover of this thesis). If we look to the AGN close to the jet line (top right corner of the cover), the torus is not in our way so we are seeing all the light produced in the AGN. In this case, we are seeing a Seyfert 1 or a Quasi Stellar Object (or quasar) in the most luminous cases.

There are a lot of mysteries surrounding the AGN phenomenon. We still do not know how they form and why some galaxies have an active nucleus and some do not. Another issue of unclear nature is how the AGN evolves and how it affects the galaxy it lives in (the host galaxy). The latter issue is the top issue of the thesis.
For this, we chose to study the radio galaxies in their first phase of existence, the so called Gigahertz Peaked Spectrum (GPS) sources (1,000 to 100,000 years) and Compact Steep spectrum (CSS) sources (100,000 to 10,000,000 years). When they were first discovered, astronomers realized that these GPS and CSS radio sources looked just like the "normal" radio galaxies, but they were much smaller. Normal radio galaxies can have jets extending well outside the host, but the CSS and GPS were completely contained in their galaxies! Until recently, it was not clear if they really were normal radio galaxies "photographed" while they were growing into the large ones known, or if GPS and CSS were old radio galaxies being surrounded by a very thick environment that impeded their expansion (like growing inside a nut shell without breaking through it). Recent studies measuring the velocity of growth of jets in GPS and CSS indicated that they are most likely young radio galaxies. This thesis focuses on these young AGN to study their relation with the hosts, in the first steps of the AGN life.

The jet of the AGN will encounter the surrounding matter as it expands through the host. It will have to literally break through and sweep away all this galactic material in its way. We then expect strong interaction between the jet and the host, which we clearly detect now and becomes the main result of this thesis.

How do we find interaction? If we throw a stone in the water, we see ripples on the surface, a perturbation in the water created by the stone. In the same way, the jet expanding through the host will create perturbations in the host. We have seen CSS sources where the shocks created by the expanding jet are firing up emission in the host. Furthermore, we have seeing cases of some CSS where their jets are compressing the gas in the host and triggering star formation. So the AGN is not only sweeping matter around, it is affecting the evolution of the host.

This thesis finds indications that the presence of an active nucleus in a galaxy can change the way that galaxy would appear and would evolve if the AGN was not present.