FAULKES TELESCOPE

Galaxies

Active Galaxies - Background Information

Author: Sarah Roberts

Active Galaxies

Introduction

Galaxies come in many different shapes and sizes, from dwarf ellipticals to giant spirals. They are classified according to their morphologies as elliptical, spiral or irregular, but they are also split into categories of whether they are 'normal' or 'active'. An active galaxy is one which emits unusually large amounts of energy, either in part of, or across all, the electromagnetic spectrum, from radio to gamma rays. Normal galaxies, as their name suggests, don't have this unusual outflow of energy, so there must be something going on at the centres of active galaxies which doesn't seem to be happening in normal ones.

Active Galactic Nuclei (AGNs)

At the centres of active galaxies are active galactic nuclei. It is from these that the huge amounts of energy, detected by astronomers, are emitted. It is generally accepted now that the source of the radiation comes from gas in the galaxy being pulled onto a supermassive black hole at the galaxy's centre. In the common model of AGN, material which has formed a disc around the black hole (an accretion disc) spirals in towards the black hole, losing angular momentum. The gravitational potential energy of the material which is falling onto the black hole is converted into kinetic energy. This in turn causes particles in the infalling material to collide, thus converting kinetic into thermal energy. The huge amount of heat this produces causes the intense radiation which can be detected by astronomers.

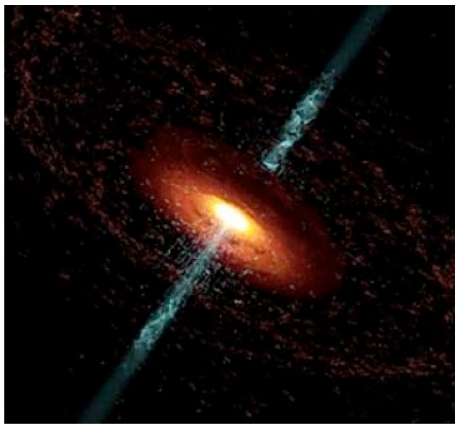

Figure 1. An artist's impression of an AGN with jets

Jets

Some accretion discs produce jets - these are highly energetic plumes of hot, ionized gas which are propelled by the twisted magnetic fields in the gas surrounding the AGN. What exactly causes these jets to form in the first place is still under investigation by astronomers, but there are a number of examples of such objects, with one of the most studied, being in a giant elliptical galaxy, M87, in the Virgo cluster, 50 million light years away.

M87

As well as being the brightest optical galaxy in the cluster, M87 is also one of the brightest sources of radio emission in the sky. It's jet was discovered in 1918 by the astronomer Heber Curtis. Curtis observed M87 and found what he described as ' a curious straight ray' coming from the galaxy. After much investigation, astronomers have now measured the extent of the jet at both optical and radio wavelengths, and found the jet to extend at least 5000 light years optically, and about 100,000 light years in radio. The jet is thought to originate from a 3 billion solar mass supermassive black hole at the centre of the galaxy.

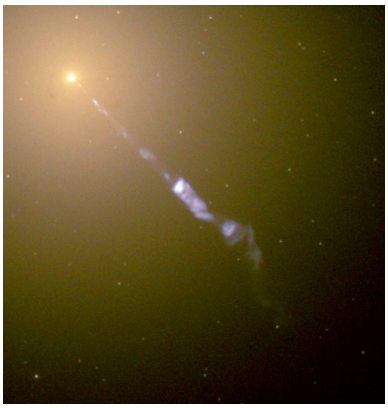

Figure 2. Hubble Space Telescope image of M87 and its jet

Types of AGN

There are many different types of AGN, such as Quasars, QSOs, Radio Galaxies, BL Lacs, Blazars, Seyfert galaxies and LINERS. Its thought that many of these AGN types are the same objects, but viewed from different angles, so that different components of the disc, jets and surrounding material are visible. If this 'unification' of AGN types is successful, it might be that there are only two distinct categories of AGN - those that have large amounts of radio emission (radio-loud) and those that don't (radio-quiet).

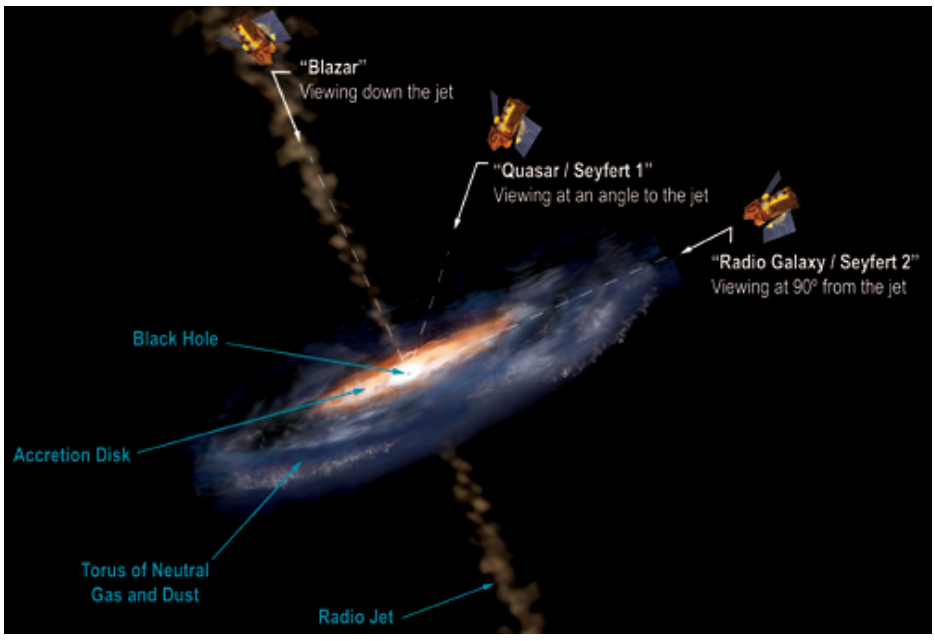

Figure 3. Diagram showing how the type of AGN which we observe is determined by our viewing angle. (Credit: Aurore Simonnet, Sonoma State University)