Spitzer Observations of Centaurus A

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Centaurus A:

- Centaurus A (Cen A) is one of the nearest large radio galaxies, at a distance of 3.4 Mpc (Israel 1998).
- The optical host galaxy, NGC 5128, is believed to be the result of a merger of a spiral galaxy with a large elliptical galaxy (Baade & Minkowski 1954). Evidence for this includes large dust lanes in its central regions, shell-like features, which are predicted by numerical simulations of mergers (see for example Malin et al. 1983) and tidal features (Peng et al. 2002).
- Previous studies have investigated the kinematics of the ionized and molecular gas, and studied the infrared (IR) morphology in terms of a recent merger (~200 million years since the core of the spiral galaxy reached the elliptical galaxy nucleus) which has produced a warped, dusty disk.

New Data Sets:

In this project we are now working with new Spitzer data including: IRAC imaging in all four bands, MIPS imaging in all three bands, high resolution IRS spectroscopy at three pointings and a low resolution IRS spectral map.

Goals:

- Image the dusty warped disk in order to understand its structure
- Measure the IR flux associated with the inner radio lobes and determine the predominant cause of this emission.
- Probe the physics of the inner regions of the galaxy via low resolution IRS spectroscopy and to investigate the relative contributions of the AGN and star-formation.

Modeling the warped disk:

Spitzer IRAC imaging of Centaurus A reveals a parallelogram shaped structure. When an optically thin warped disk is seen in emission, the edges of the disk in the line of sight are regions of higher surface brightness. It is therefore possible that the warped disk is similar in shape to that revealed by Spitzer IRAC imaging. We infer that the dusty disk must be nearly optically thin in the mid-infrared.

A model of emission from a warped disk is produced by considering the disk to consist of a series of tilted rings of different radii. Each ring is described by two angles: a precession angle and an inclination angle. Model images were produced by integrating the emission along the line of sight, through the model disk, beginning with the precession and inclination angles of Quillen et al. (1993) and varying these angles in order to fit the IRAC image by eye.

The Spitzer IRAC images allow us to better study the outer parts of the disk, compared with previous CO(2-1) spectro (Quillen et al. 2002). The best matching model to the IRAC morphology was produced by allowing the disk to twist to a greater extent than previously thought. This model predicts that the disk alternates between having the southern and northern side nearest to the observer.

Figure 1. IRAC Imaging

Figure 2. Greyscale: 24 Om MIPS image; Contour: 21cm VLA map

Figure 3. Inner radio lobe detections in each of IRAC bands 1 to 4 (left to right)

Figure 4: The IR SED of the inner radio lobe of Cen A

Highlights:

Using new Spitzer data from IRAC, MIPS and IRS we investigate the properties of the nearby radio galaxy Centaurus A. The proximity of this galaxy allows us to study its activity in more detail than other, more distant radio galaxies. In addition the host elliptical galaxy has undergone a merger with a spiral galaxy relatively recently resulting in prominent dust lanes and a warped, dusty disk. The morphology of the dusty disk, in particular the half warping parallelogram structure, has been used as a guide to modelling the disk as an optically thick, twisted disk. These new data indicate that the disk is more twisted than previously believed and the edge of the disk closest to the observer switches from north to south. IRAC and MIPS imaging have been used to measure the IR emission associated with the inner radio lobe and it has been shown that the origin of this emission is likely to be non-thermal, i.e. this emission is synchrotron and not due to star-forming regions. Low and high resolution spectra have been obtained with IRS and will be used to investigate the variation of physical parameters, such as ionization parameter, as a function of position through the dusty disk.

Figure 5: The strength of the 6.2 μm PAH feature (left) and the [NII] 15.6 μm emission line (right) as a function of spatial position.

Figure 6: High resolution IRS Spectra

Figure 7: Low Resolution IRS Spectral Mapping

Figure 8: High Resolution IRS Spectra