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AN INFRARED JET IN CENTAURUS A (NGC 5128): EVIDENCE FOR INTERACTION BETWEEN THE ACTIVE NUCLEUS AND THE INTERSTELLAR MEDIUM

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Summary

The giant elliptical NGC 5128 (Centaurus A) is nearby radio galaxy containing a luminous active nucleus embedded in a broad dust lane (Graham 1979). A beam of relativistic particles emanates from the nucleus, generating X-ray and radio jets as well as extensive radio lobes and optical filaments in the outer parts of the galaxy (Burns, Feigelson, and Schreier 1983; Brodie, Konigl, and Bowyer 1983). The nature of this active galaxy has been studied at many wavelengths, but the nuclear region is rendered optically unobservable by heavy obscuration in the dust lane; therefore, studies of nuclear structure must be carried out at near-infrared wavelengths where the effects of extinction are greatly reduced. Giles (1986) constructed the first high resolution near-infrared maps of Cen A by scanning a small aperture across the source; this work pinpointed the location of the nucleus and also revealed unexpected asymmetries in the near-infrared light distribution.

In the present study, higher resolution near infrared images of the visually-obscured central region of Centaurus A have been obtained in order to investigate the effects of the active nucleus on the surrounding galaxy. We present J(1.25μm), H(1.65μm), and K(2.2μm) images of the central 40" of the galaxy, taken with the Univ. of Texas InSb array camera on the Anglo Australian 3.9 meter telescope. These images reveal a jet extending ~10 arcseconds to the northeast of the nucleus at the same position angle as the X-ray and radio jets. The infrared jet is most prominent at the shortest wavelength (1.25 μm), where its brightness surpasses that of the nucleus (figure 2).

The blue appearance of the infrared jet is remarkable considering the heavy obscuration that is evident at visual wavelengths. The amount of reddening in the vicinity of the jet is determined from the measured colors of the stellar core of the galaxy (figure 3), and this value is used to generate an extinction-corrected energy distribution (figure 4). In contrast to previously studied optical and infrared jets in active nuclei, the short-wavelength prominence of the Cen A jet indicates that it cannot be attributed to synchrotron emission from a beam of relativistic electrons. The remaining viable mechanisms involve an interaction between the interstellar medium and the active nucleus: the infrared radiation from the jet may be due to emission from interstellar gas that has been entrained and heated by the flow of relativistic particles from the nucleus (cf. Brodie, Konigl, and Bowyer 1983); alternatively, luminous blue stars may have been created by compression of interstellar material by the relativistic plasma (De Young 1981). To investigate these proposed mechanisms, near-infrared spectroscopic studies of Cen A are in progress to look for collisionally excited molecular hydrogen emission lines and recombination lines from ionized gas.

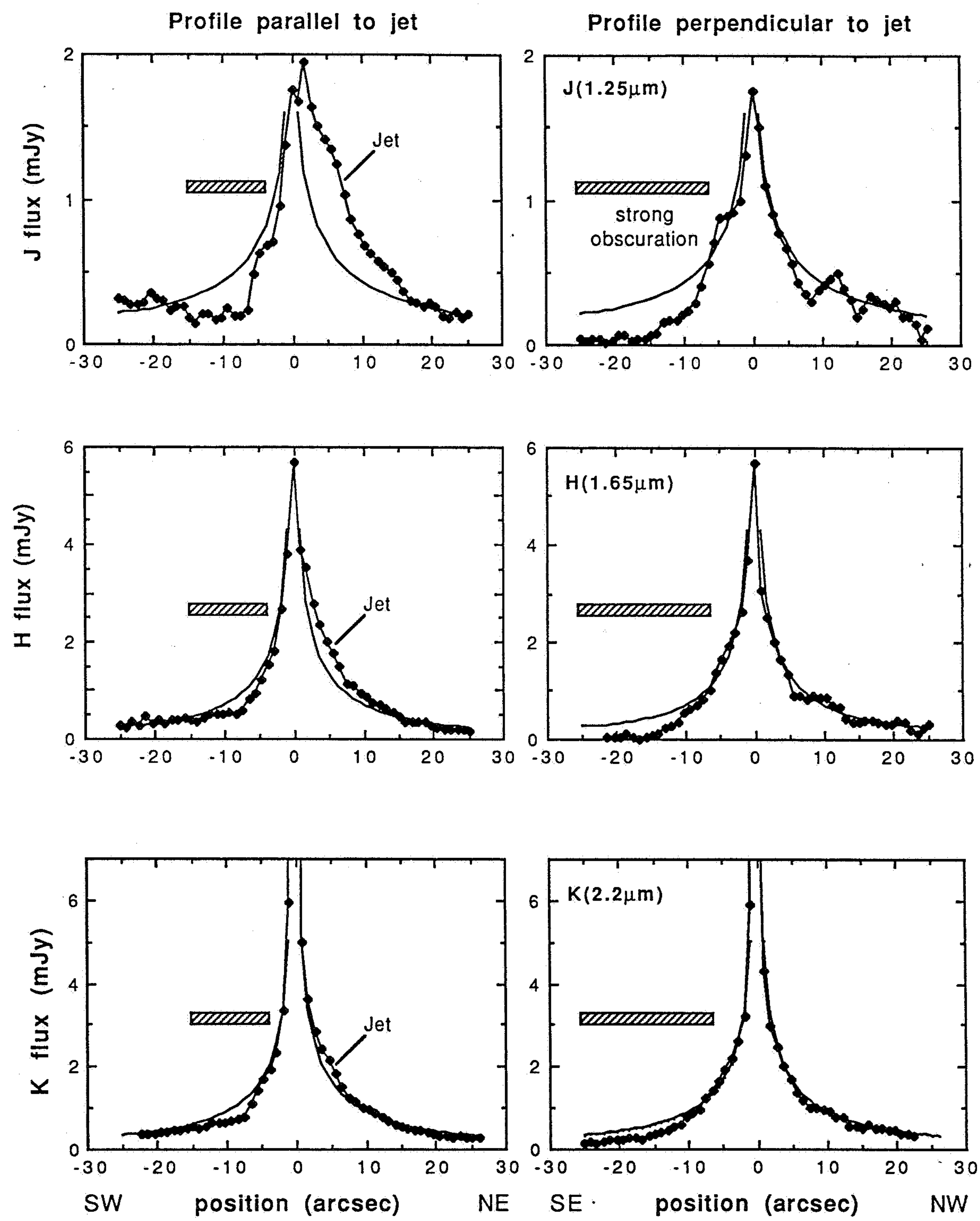

Fig. 2 – Slices through the infrared jet and the galaxy nucleus.

In order to compare the structure of the jet at all three wavelengths, we present slices directly through the nucleus and the jet (*left side of figure*); in the perpendicular direction, the slices pass through the nucleus alone (*right side*). All of the profiles intersect with the prominent dust lane; these regions of strong obscuration are indicated by cross-hatched bars in the figure. The underlying stellar bulge of the galaxy has been identified by fitting de Vaucouleurs $r^{1/4}$ profiles to the central region of the galaxy (*solid lines*); relative to these $r^{1/4}$ profiles, the jet is clearly seen in emission to the NE of the nucleus, and it is brightest at the shorter wavelengths.

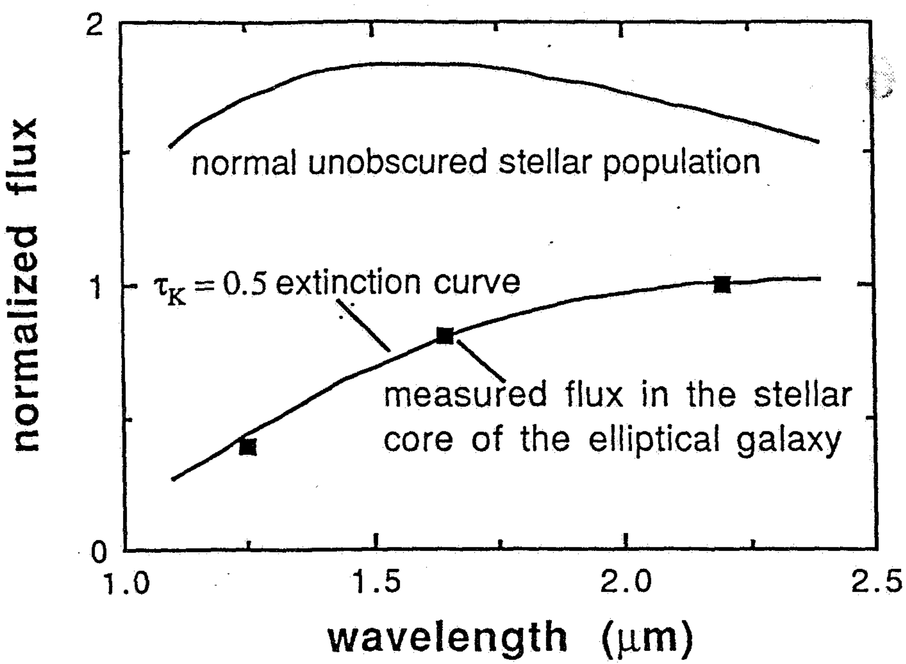

Fig. 3 – Near-infrared colors of the stellar core of Cen A.

The brightness of the stellar core of Cen A was derived from $r^{1/4}$ profiles fitted to the central region of the galaxy (1"< r < 6"); these profiles yield colors that are much redder than those of a normal stellar population in an elliptical galaxy. The observed colors are consistent with a normal extinction law and a 2.2 μm optical depth of 0.5, which implies that the *visual* flux from the core of the galaxy is attenuated by a factor of ~50 (A_V ~ 4 mag). It is evident from figure 2 that the extinction is even greater within the dust lane.

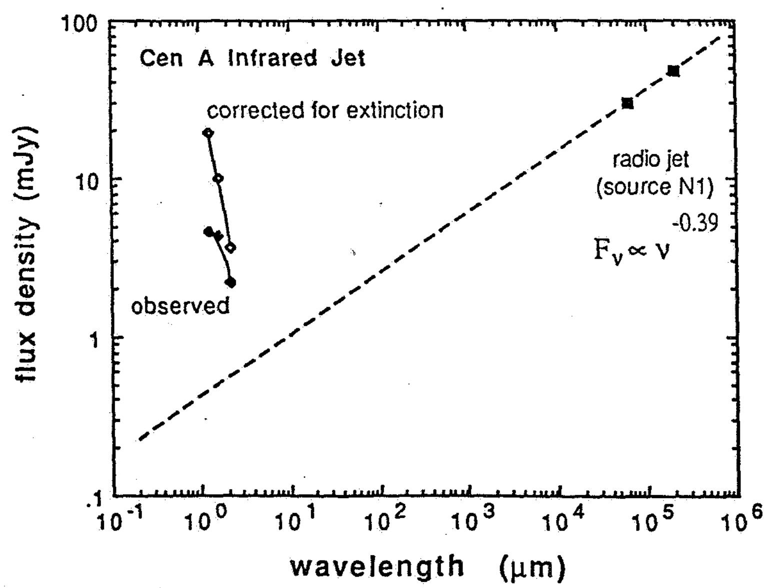

Fig. 4 – Energy distribution of the infrared jet.

The flux from the infrared jet was calculated by subtracting the underlying $r^{1/4}$ galaxy profile from the observed image, as indicated in figure 2. The infrared fluxes in this figure were computed for a 3.6"x1" beam so that they could be directly compared with VLA measurements of the radio continuum jet N1 (Burns, Feigelson, and Schreier 1983). Filled triangles denote the measured flux of the jet, and open triangles represent extinction-corrected fluxes calculated using the optical depth from figure 3. It is evident from the figure that neither the slope nor the amplitude of the near-infrared emission is consistent with synchrotron emission from the radio jet.