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THE INTERACTION BETWEEN JETS AND CLOUDS IN THE 3CR GALAXIES

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From the HST/WFPC2 3CR Snapshot Survey, data taken with the filter F555W, F702W and narrow-ramp, a set of galaxies with noticeable extended structure were selected (e.g. 3C 79, 3C 135, 3C 234, etc). All of these objects show large regions of [OIII] λ 5007Å emission (narrow ramp filter) and the broad-band filters data show similar structures indicating the presence of strong emission in several lines over these regions. The morphology observed seems to be related (e.g. same position angle, direct overlapping or similar shape) with the radio-jet. For some candidates with these properties GMOS/Gemini spectroscopy was taken. These data (both HST direct imaging and Gemini spectroscopy) can be tested with diagnostic diagrams and total UV photons budget to understand the source of energy that is ionizing the gas. This source of ionization was commonly believed to be the UV photons emitted by the powerful active galactic nuclei (AGN), but several of these objects show clearly that shocks produced by the radio jet are the main cause of the observed gas line emission. We show in this work, the results obtained over some of these radio-galaxies: 3C 135, 3C 180, 3C 234 and 3C 284.

For 3C 135 the line ratios from GMOS/Gemini long-slit spectra, taken in the jet orientation, indicate the presence of high speed shocks in the observed region. From the [OIII] λ 5007/Hβ and the Ne[III] λ 3869/[OII] λ 3727 ratio we estimate that a model with v=500 km s^{-1} plus a precursor HII region (Dopita et al. 1996) can explain our observations quite well. The [OII] λ 3727/[OIII] λ 5007 ratio, which is very sensitive to the parameter U, shows that the observed line ratio does not follow the dilution model of the ionizing radiation filed for a central source of photons (U$\sim$r^{-2}). Unless we consider a large increase of the density of the ISM, this behavior indicates that the ionization is not produced by photons of the AGN. We conclude that the extended narrow-line region (ENLR) of 3C 135 is the result of the interaction of the radio jet with the ISM gas.

In the case of 3C 180, the line emission can be found up 12 arcsec to the SW and to 8 arcsec to the NE, but in this range there are gaps with low or no measurable flux. As in 3C 135 shocks with v=500 km s^{-1} plus a precursor HII region can explain our observations quite well. Also the ratio [OII] λ 3727/[OIII] λ 5007 is not consistent with photoionization by the AGN.

3C 234 is a well known radio-galaxy. There is a bright region to the West that is shown by the WFPC2/HST [OIII] λ 5007 image. As in the others galaxies, shocks with v=500 km s^{-1} plus a precursor HII region can explain our observations. The evolution of the U parameter, estimated from the [OII] λ 3727/[OIII] λ 5007, do not shown any decrease of intensity over the region.

Finally, 3C 284 displays two symmetric spots to the NE and SW. The GMOS/Gemini spectra shows that there are three components with different velocities (−500, 0 and 270 km s^{-1} relative to the galaxy) to the SE. For the [OIII] λ 5007/Hβ ratio a model with less than v=500 km s^{-1} plus a precursor HII region can explain this emission lines, but for the Ne[III] λ 3869/[OII] λ 3727 ratio a higher velocity is needed.

REFERENCES

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