Molecular Gas in Elliptical Galaxies

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Abstract. The distribution and kinematics of the molecular gas in elliptical galaxies give information on the origin and history of the gas and the rate of star formation activity in ellipticals. I describe some preliminary results of a survey which will more than double the number of elliptical galaxies with resolved molecular distributions.

1. Introduction

Not long ago it became clear that many elliptical galaxies do have small amounts of cold interstellar gas and dust (e.g. Knapp et al. 1989; Goudfrooij et al. 1994). The gas and dust have significance far beyond their small masses: their distribution and kinematics provide vital clues to the evolution of ellipticals (van Gorkom & Schiminovich 1997; Sadler et al. 2000). To date, most work on the distribution and kinematics of neutral gas in ellipticals has focused on the atomic gas.

The present contribution describes a survey to make maps of the CO emission in ten elliptical galaxies. The main selection criterion for this sample (after the classification issues, which are admittedly difficult) is the galaxies’ single dish CO line strengths. The resolution of the CO data is about 6″, which is 20 pc (!) for the nearest galaxies and 1.5 kpc for the most distant ones.

The goals of the project are to understand (1) the origin of the molecular gas in ellipticals and its prospects for long-term stability; and (2) how much star formation activity is taking place in ellipticals. The molecular gas distribution and kinematics are being compared with the atomic gas, stellar kinematics, and radio continuum and Hα emission. The sample galaxies are found in a variety of environments—some are isolated, some in loose groups, and some in the center of Virgo cluster. They also have a wide range of luminosities; some have active nuclei and some show visible signs of recent interactions.

Seven of the ten sample galaxies have already been observed with the BIMA millimeter interferometer, and five are clearly detected. Figure 1 shows the stellar distributions and CO maps for two of them.

2. Some Initial Results

Except for NGC 185 and NGC 205, the smallest members of the sample, the molecular gas is distributed in a smooth, regular disk in solid body rotation. There is a strong asymmetric warp in the CO of NGC 3656, but otherwise the
disks are not disturbed. In two cases the galaxies’ stars are known to have large velocity dispersions and small rotational velocities; the CO rotation is consistent with that of the stars. Usually the HI kinematics are found to be inconsistent with those of the stars, which is taken as evidence for an external gas origin. Perhaps the situation is more complicated for the molecular gas.

A remarkable result comes from comparing the molecular gas distribution in NGC 5666 to the radio continuum emission in that galaxy (Wrobel & Heeschen 1988). The radio continuum emission is extended; it has exactly the same extent as the resolved CO emission. Thus, the radio continuum and FIR emission can be attributed to star formation (3 M$_\odot$ per year) rather than to an active galactic nucleus or to an old stellar population. The other galaxies in the sample will help to show whether this situation is common or uncommon.

Comparisons of the molecular gas properties and the star formation activity in the different galaxies (isolated vs. in clusters, giant vs. dwarf, and so on) will allow us to probe elliptical galaxy evolution as a function of galaxy properties and/or environment.

References

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