Properties of the ISM in dwarf galaxies

Project C1

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Molecular Clouds in IC 10

The Local Group dwarf galaxy IC 10, with a metallicity of $Z \approx {}^1/_5\ Z_\odot$, using the Plateau de Bure mm-interferometer, with the aim to study the detailed structure of its molecular clouds (Bornhöft 2003). The resulting map of the CO(2→1) intensity, which has an angular resolution of 2.0″ × 1.7″ (19 pc × 15 pc) is displayed in **Fig. 1**. We have determined the conversion factor relating the observed CO intensity to the H_2 column density, assuming virialization of these clouds. We find a conversion factor of $N_{H2}/I_{CO} = X = (1.1 \pm 0.6) \cdot X_{Gal}$. This is in line with what has been found for the Magellanic Clouds. The line ratios are relatively low, intensity-wise $I_{21}/I_{10} \approx 0.3 \ldots 0.5$.

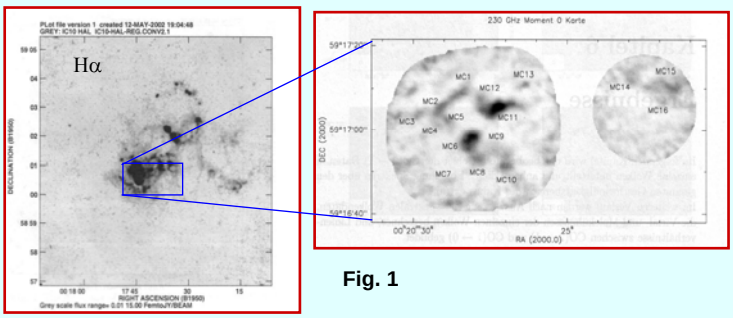


Fig. 1

Gas and Dust in NGC 4449

The dwarf galaxy NGC 4449 has a metallicity of $Z \approx {}^1/_4\ Z_\odot$. We have used the IRAM 30-m telescope and the JCMT to map its distribution of the molecular gas and the cold dust (Böttner et al. 2003). In **Fig. 2** (left) these are shown, along with the HI and Hα images. The HI mass in the inner part of NGC 4449 investigated hee is $M_{HI} = 1.5 \cdot 10^8\ M_\odot$,. The H_2 mass inferred from our CO maps is $M_{H2} = 3.4 \cdot 10^8\ M_\odot$, hence the total gas mass in the inner part of NGC 4449 is $M_{gas} = 4.9 \cdot 10^8\ M_\odot$.

The properties of the dust in NGC 4449 have been analyzed by fitting modified black-body spectrum to the observed total dust continuum emission, shown in **Fig. 2** (right). We find that the cold dust is best described by three components, which have temperatures of, respectively, $T_1 = 168 \pm 10$ K, $T_2 = 39 \pm 3$ K, and $T_3 = 16 \pm 2$ K. An integration of the continnum spectrum reveals that the coldest component represents a dust mass of $M_d = 3.8 \cdot 10^6\ M_\odot$, the warmer ones having negligible contributions. This implies a gas-to dust ratio of 130.

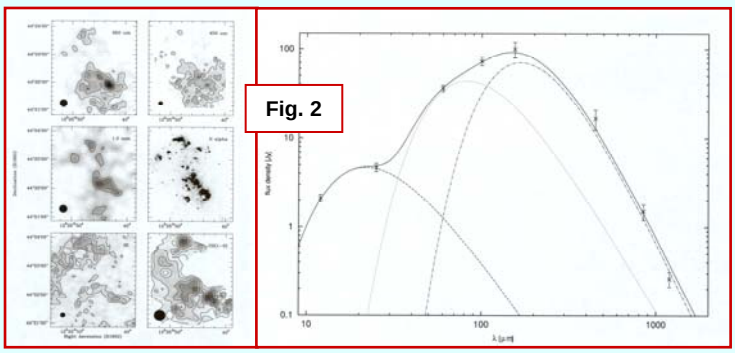


Fig. 5

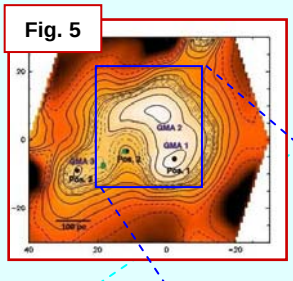
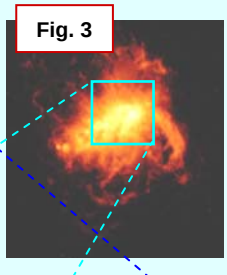


Fig. 3



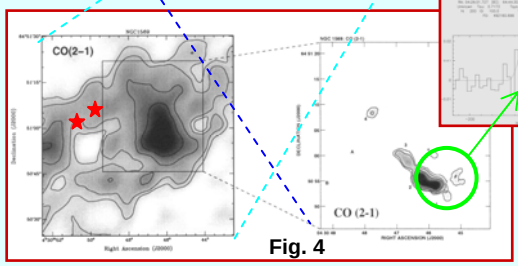


Fig. 4

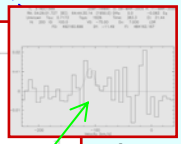


Fig. 6

NGC 1569: a template starburst

This dwarf galaxy is really a template starburst dwarf system with a bona-fide wind. It is has experienced a major starburst which ceased some 10^7 yr ago, having left behind two prominent, giant star clusters (marked by the two red stars in **Fig. 4**). The impact on the ISM of NGC 1569, studied by Mühle (2003), is rather obvious.

We have observed NGC 1569 in the CO and the CI line using a variety of telescopes. In **Figs. 3 - 6** summarize the current status. The CO(2→1) map was obtained with the 30-m telescope, equipped with the HERA receiver (11" beam). The high-resolution CO(2→1) map was obtained by Taylor et al. (1999) using the PdBI. The CO(3→2) line was mapped with the HHT, indicating the presence of warm ($T_{kin} > 110$ K) molecular gas. The central portion of the galaxy is featured by a funnel, also visible in the HI line (Mühle et al. 2005), the "walls" of molecular gas marking its boundaries at high contrast. The gas-deficient central region of the starburst must be considered as a giant PDR. Using the JCMT, we have carried out a search for the $^3P_1 \rightarrow {}^3P_0$ transition of the atomic carbon (11" beam). A spectrum was obtained, with a 3-σ detection after about 7 hrs. on-source integration time (**Fig. 6**).

Investigations as described above are crucial to understand the evolution of low-mass galaxies, the deemed building blocks of larger stellar systems. For objects in the northern sky, the IRAM 30-m telescope and the JCMT will be our prime instrumentation to carry out such investigations, while dwarf galaxies in the southern sky will be observed with MOPRA and NANTEN2. As in case of the LMC, these latter telescopes yield the perfect matching when mapping the CO line in several transitions and the [CI] line.

References

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Pico Veleta **PdB** **JCMT** **HHT** **NANTEN2**