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Dust Emission from a Large Scale Shock Near the Galactic Center

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Abstract. AFGL5376 is a prominent 25 μm source near the Galactic Center produced by a large scale ($\sim$100 pc) shock that extends well above the Galactic plane. This shock region coincides with the edge of a vertical radio continuum feature, which appears to be at the surface of a 150-pc lobe that encompasses the Galactic center. There is no evidence for nearby star formation. The unusually warm ($T \sim$100 K) dust emission peak, traced by the 25 μm emission, is clearly surrounded by high velocity ^{12}CO(2-1) emission. We are currently conducting a comprehensive observing study of the region including Spitzer IRS and MIPS observations. Our continuum observations are aimed at allowing the derivation of mass and temperature distribution at sub-parsec resolution. Here we present MIPS 24 μm observations in combination with MAMBO observations at 1.2 mm wavelength. The latter reveal the presence of strong millimeter continuum emission in the vicinity of AFGL5376. We present a first estimate of the masses of the cold molecular clouds that are associated with this region. Our complete set of continuum Spitzer and (sub-)millimeter emission measurements together with our IRS spectroscopy will be used later to constrain magnetohydrodynamic models for the production of this highly energetic feature.

1. Scientific Motivation

The center of our galaxy is very well suited for studying the effects of a variety of physical processes important for understanding star formation and the magnetohydrodynamics of the interstellar medium. The presence of much stronger magnetic fields than in the galactic disk and strong shear due to differential rotation allow efficient studies of their effects on the energetics of the interstellar medium. The excitation temperatures of molecular clouds in the Galactic Center are predominantly elevated with respect to the observed dust temperatures (Güsten 1989; Pierce-Price et al. 2000), an indication that physical processes other than radiative heating by stars play an important role in the energetic balance of molecular clouds.

2. The Source: AFGL5376

The Galactic center source AFGL5376 (l=-0.5 degrees, b=+0.43 degrees) is particularly unusual and interesting for a variety of reasons. First, it is extremely bright and extended at the wavelength where it strongly peaks - 25 μm - (Fig. 1) rivaling at that wavelength some of the brightest star formation complexes in the Galaxy (Uchida et al. 1994). However, there is no evidence for star formation in this region. Apparently, the luminosity is owed to mechanical dust heating by a strong, 100-pc-scale shock occurring at the interface between two molecular cloud systems (Fig.1, left). The shock is strong enough to have created an extended ionization front at its leading edge, and to have dissociated CO along the hot ridge where the infrared emission arises (Fig. 1, right).

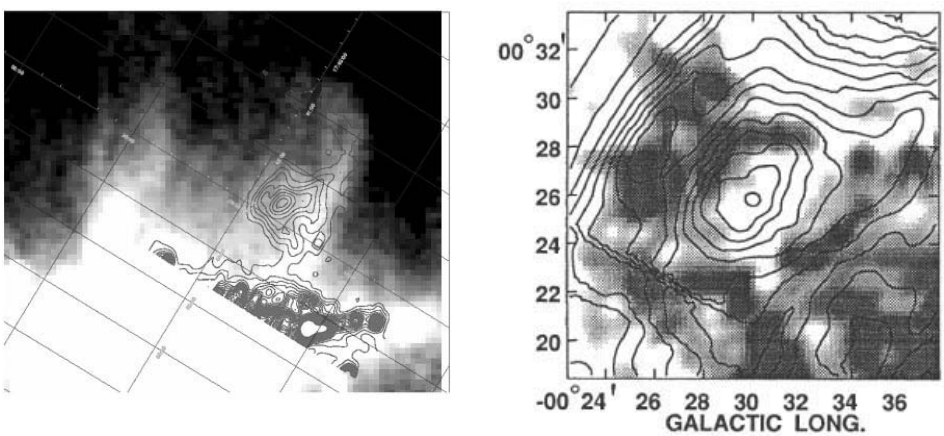

Figure 1. *left:* Large scale Nobeyama 10 GHz image (grey scale, Handa et al., 1987) of the Galactic center with IRAS 25 μm contours overlayed. The Galactic Center Lobes East and West can be seen as vertical structures in the grey-scale representation of the Nobeyama data. AFGL5376 is the prominent 25 μm feature at center right in the image, to the immediate East of the radio emission from the Galactic Center Lobe West. The Galactic plane is horizontal, and is traced by the highest 25 μm contours. *right:* AFGL5376 in ^{12}CO(2-1) emission (grey scale, from Uchida et al., 1994) with an overlay of the IRAS 25 μm emission (contours).

3. Recent Results

A recent Spitzer/MIPS image at 24 μm (Fig. 2) shows the shock fronts in remarkable detail. AFGL5376 appears to be intimately associated with the vertical Galactic center magnetic field; several of the nonthermal radio filaments are observed to lie along the shock front, or close to it, suggesting that the shock has a significant magnetic component (Morris, Uchida, & Staguhn, in prep.; Yusef-Zadeh, Hewitt & Cotton, 2004, ApJS, 155, 421). The 24-μm MIPS image shows that the infrared emission from the region is stratified into broad vertical bands, suggesting that the magnetic field has played an important role in crafting the morphology of the dust distribution. Our preliminary 1.2 mm

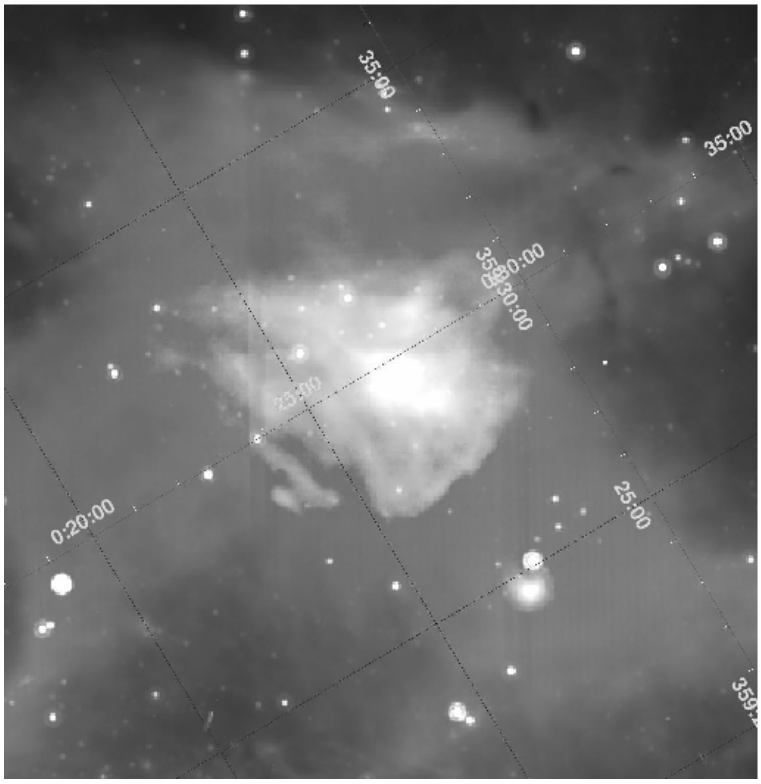

Figure 2. Spitzer-MIPS 24 μm image of AFGL5376. Superimposed is a Galactic coordinate raster with a separation of $5'$.

observations (so far only 1/3 of the granted telescope time was scheduled) with the MAMBO camera on the IRAM 30 m telescope are shown in Fig. 3. We also obtained 350-μm observations with the CSO SHARCII camera, however we are still having problems with the calibration of those data, in particular the flux density offset of the extended emission is still uncertain. We therefore consider only the MAMBO results for the following rough mass estimate: Assuming a dust temperature of 20 K and dust emission properties as derived for the entire Galactic center region by Pierce-Price et al. (2000) the observed integrated flux from the region shown in Fig. 3 corresponds to a total cloud mass of $M_{\rm cloud}$ $3 \times 10^5 {\rm M}_\odot$.

4. Outlook

Because of its unique character among Galactic objects, AFGL5376 may be a key object for understanding activity in galactic nuclei and galactic mergers in general. All of the elements of this object – a concentration of molecular gas, powerful shocks resulting from high-velocity cloud interactions, and strong magnetic fields – are likely present in AGNs and starburst nuclei, so understanding of such environments would undoubtedly be facilitated by our being able to study this nearby example in detail. To this end, we are continuing the process

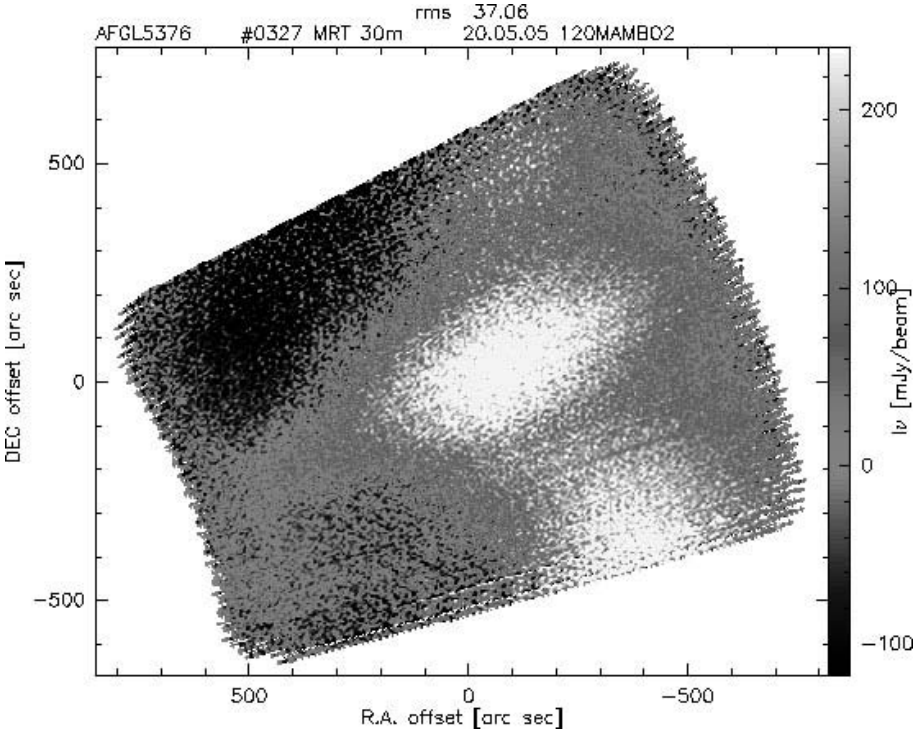

Figure 3. MAMBO 1.2 mm flux density image of AFGL5376. The peak flux density at the (0,0) position coincides with the 24 μm peak flux seen in Fig. 2.

of studying AFGL5376 at a variety of wavelengths in order to model the shock in as much detail as possible.

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