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GAS FEEDING TOWARD THE GALACTIC CENTER

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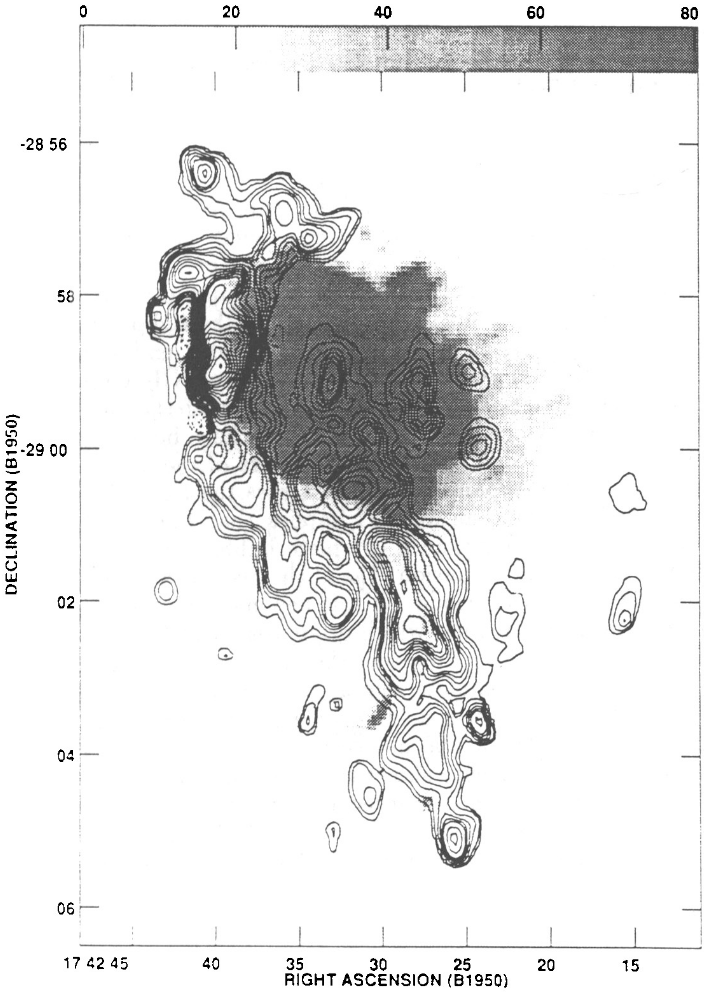

Fig. 1. The integrated intensity of the NH_3 (J,K)=(3,3) emission (*contours*) toward the Galactic center from a eleven-field synthesis on the VLA, superposed on the radio continuum emission at 6 cm (*greyscale*).

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THE MOLECULAR CLOUDS CLOSEST TO THE CENTER The previous two talks in this session have shown the importance of the nucleus of the Milky Way as the host to a possible massive black hole. SgrA* is apparently surrounded by a circumnuclear ring first seen in the HCN J=1–0 emission (Gusten *et al.* 1987). Infall from the circumnuclear ring could explain the ionized streamers which appear to orbit SgrA* (Lo and Claussen 1983; Serabyn and Lacy 1985). Recent studies in the NH_3 emission using the Nobeyama Millimeter Array (Okumura *et al.* 1989; 1991) and the Very Large Array (Ho *et al.* 1991) have suggested that a streamer may feed the Galactic center from the southern cloud M-0.13-0.08. Here we show a second streamer originating from the eastern cloud M-0.02-0.07 as well. In both cases, interactions between the molecular clouds and supernovae seem to be important, and can be seen in position-velocity diagrams. This may be the mechanism by which gas is pushed toward the central gravitational field.

NEW VLA NH_3 STUDIES We have recently added six new fields to our original five-field mosaic of the NH_3 (J,K)=(3,3) emission in the Galactic center region (Ho *et al.* 1991). These new fields were aimed at exploring the western and northern edges of the supernova remnant SgrA-East (Figure 1). The correspondence between the molecular cloud structures and the boundaries of the continuum emission is excellent. Hard "edges" in the radio continuum emission of SgrA-East are found next to "walls" of molecular emission, and smoother "edges" in the continuum correspond to absences of NH_3 emission, suggesting that the molecular material bounds the expansion of the supernova remnant. Figure 2 is a position-velocity plot across the northern boundary demonstrating the impact of the SNR. Note the classic signature of the inverted "C", which is due to projection of the expansion motion across the front. That the signature is an inverted "C" rather than an "O" implies that the structure is only part of an expanding shell rather than a complete bubble. The red-shifted motions suggest that if this is an expansion, the shell faces away from us, with SgrA-East in front of the 50$\mathrm{km\,s^{-1}}$ cloud. In this new mosaic map (Figure 1), one can see clearly the southern streamer which originates in M-0.13-0.08 and ends near the circumnuclear structure. However, the circumnuclear structure as seen in NH_3 does not resemble a complete ring as is the case of HCN (cf. Gusten *et al.* 1985). This is not due to short-spacing problems on the VLA as identical results are obtained with the MPIfR 100 m telescope at Bonn. Instead, inspection of emission as a function of velocity shows that the northern and southern portions of the circumnuclear ring are composed of high velocity emission (at velocity offsets of 100 $\mathrm{km\,s^{-1}}$) which radiate strongly in HCN emission but only faintly in NH_3 emission. This is either a chemical effect due to relative abundance variations or an excitation effect.

HCN MAPS IN THE J=1–0 AND J=3–2 LINES Since the NH_3 circumnuclear structure appears so different as compared to HCN, one is naturally concerned whether a connection between the central region and the molecular clouds at 10 pc can be legitimately studied using different molecular probes. To elucidate the situation, we obtained new single-dish maps of the extended HCN emission in the J=1–0 line using the IRAM 30 m telescope. Figure 3 shows the integrated

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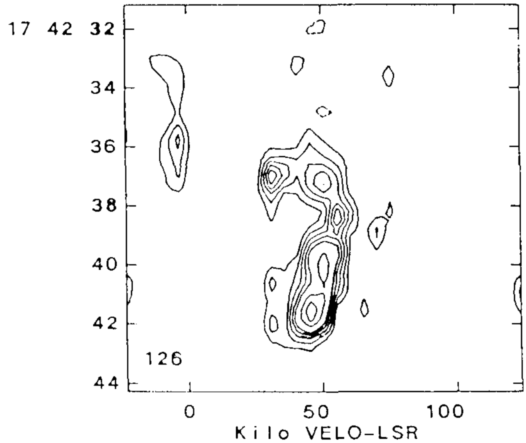

Fig. 2. A position-velocity plot of the NH_3 emission across the northern boundary of the SgrA-East Remnant. Note the classic "C" pattern, which can be interpreted as an expanding shell on the rear of SgrA-East.

emission and it is quite evident that the circumnuclear structure is embedded in a large emission complex. The apparent isolation of the circumnuclear structure in the interferometric maps may be due in part to the limited primary beam coverage. By inspection of the emission as a function of velocity, it is clear that the connection of the nucleus to the extended emission occurs at specific velocities. This is clearer in the new maps we obtained in the higher excitation J=3–2 line with the CSO 10 m telescope. Because of the same factor of 3 in wavelength and telescope diameter, the two HCN studies have the identical angular resolution of 20″. We find that the absorption effects clearly evident in the J=1–0 line are supressed in the higher transition. The channel maps immediately show that the absorption features are due to a low-density screen (since they are absent in the higher transition) which is extended (since the absorption is complete over the entire field of view). The extended emission evident in these maps show that the high-velocity material, which are quite isolated, do connect to material further out as one approaches the lower emission velocities. In addition to the streamer which connects the nuclear region to the southern 20 $\mathrm{km\,s^{-1}}$ cloud, Figure 3 shows another streamer which connects to the eastern 50 $\mathrm{km\,s^{-1}}$ cloud.

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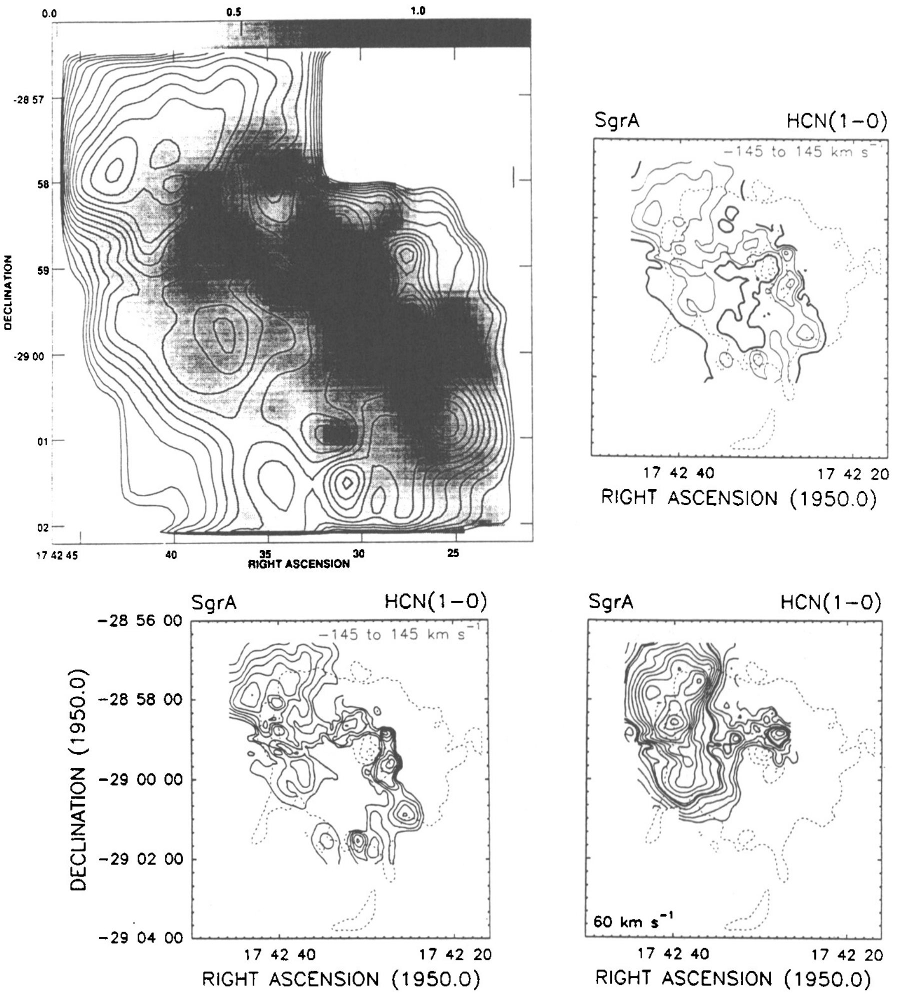

Fig. 3. Integrated HCN J=1–0 emission toward the Galactic center *contours* superposed on the ratio of J=3–2 line to J=1–0 line *greyscale*. If the greyscales were reproduced better, one would see an extended ridge in the line ratio suggesting a density enhancement in a boundary layer between the 50 km s^{-1} cloud and the SgrA-East remnant. A maximum in excitation would also be seen where the eastern streamer terminates at the circumnuclear structure. Also shown are three panels of the J=1–0 emission: integrated emission at half intensity; the more intense contours of the integrated emission; the 60 km s^{-1} channel.

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DISCUSSION

K.Y. Lo A comment on R. Ekers' question on the relative separation of Sgr AE and Sgr AW: If the circum-nuclear molecular material surrounding the ionized gas in Sgr AW is located all within a few pc (even though the material may not be a ring or disk), the fact that the northern portion of this material lies behind the radio continuum source (Sgr AE & W) implies the separation of Sgr AE and Sgr AW cannot be larger than a few parsecs.

P.T.P. Ho We certainly agree that Sgr A East and Sgr A West is very likely to be within a few parsec of each other. We think there are certainly NH_3 material both in front of and behind both Sgr A East and Sgr A West. A close distance between all these emission complexes is consistent with the kinematics and interactions which have been seen.

R. Ekers There is considerable evidence that indicate that Sgr A East is behind Sgr A West. Doesn't this suggest that your NH_3 ridge on the East of Sgr A East must be behind the CND material which is clearly associated with the Sgr A West spiral?

P.T.P. Ho That is certainly possible. The nice spectral index maps from Pedlar et al certainly demonstrated that Sgr A East is behind Sgr A West. The ridge east of Sgr A East wraps around Sgr A East and appears to be physically and kinematically connected with the southern 20 km/s cloud to the south. The question therefore is indeed whether Sgr A East and Sgr A West are physically connected or in contact or very close. If so, the NH_3 ridge can be behind or in front of the Sgr A West Spiral.

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