MOLECULAR FAN OF 360-pc RADIUS IN THE GALACTIC CENTER REGION

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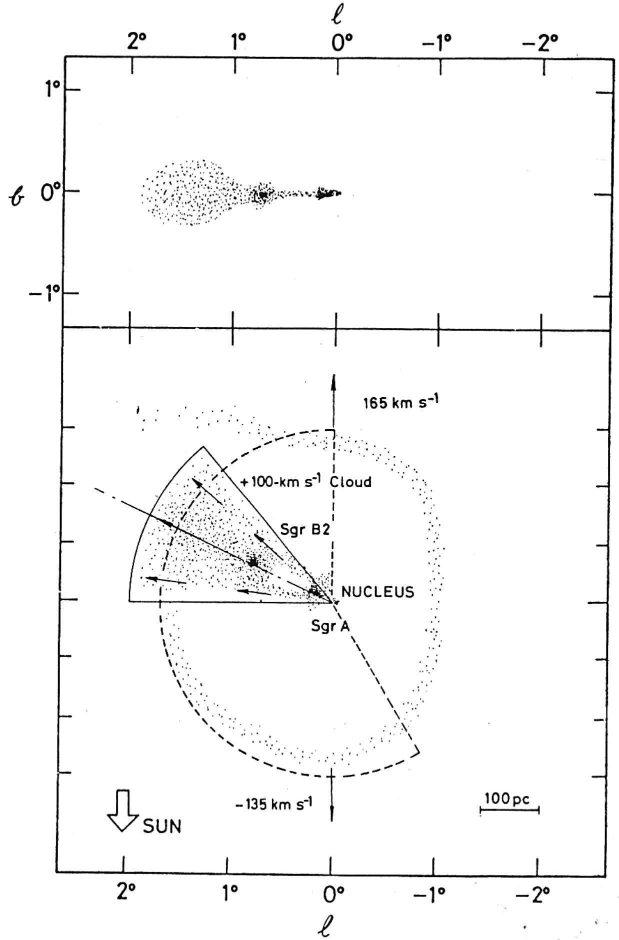
Molecular hydrogen of $\gtrsim 10^8 M_\odot$ exists in the galactic center region, as has been revealed by recent observations of molecular emission lines (see e.g. Oort 1977). In the inner region of $\ell \lesssim 3^\circ.0$ most of the dominant emission features concentrate at $0^\circ.0 \lesssim \ell \lesssim 2^\circ.0$ and $0\ \mathrm{km\ s^{-1}} \lesssim v \lesssim 100\ \mathrm{km\ s^{-1}}$ extremely unevenly with respect to the galactic center (see Fig. 1). As a model of the molecular complex we propose a fan of 360-pc radius whose pivot is at the center. The vertical angle of the fan is about 50° and the central line of the fan makes an angle of about 60° to the line of sight. Molecules in the fan are flowing out radially from the center with a velocity of 110-140 km s^{-1}. The ℓ-v pattern of the fan model is superposed on the CO map in Fig. 1. The model can explain the whole structure of the molecular complex as well as several fine details such as asymmetry in emission line profiles (Fukui et al. 1979). As for Sgr A and Sgr B2, numerical calculations of molecular line profiles have been made by using the large velocity gradient approximation. The calculations show that the broad and asymmetric line profiles in the complex are well reproduced by the fan model. Further, an isotope effect on line shape is predicted, which will be useful as an observational check of the fan model. Additionally, the carbon isotope ratio $^{12}C/^{13}C$ in HCN and CO was estimated to be 10-20 in the Sgr A +50-km s^{-1} cloud.

The origin of the molecular fan is most directly interpreted as anisotropic mass ejection from the center. Similar fan-like features are found in the external galaxies by optical workers. The total kinetic energy of the complex amounts to $\gtrsim 10^{55}$ erg and the characteristic duration of the phenomenon is estimated to be 3×10^6 yr. At $\ell \sim 1^\circ.3$ the complex shows an enormous thickness of about 140 pc (Inatani 1978), and a past active phase of the nucleus may be suggested. Fig. 2 shows a schematic diagram of the fan model.

This paper is a summary of part of the Doctoral thesis of the author (Fukui 1978).

B. H. Andrew (ed.), Interstellar Molecules, 209–211.



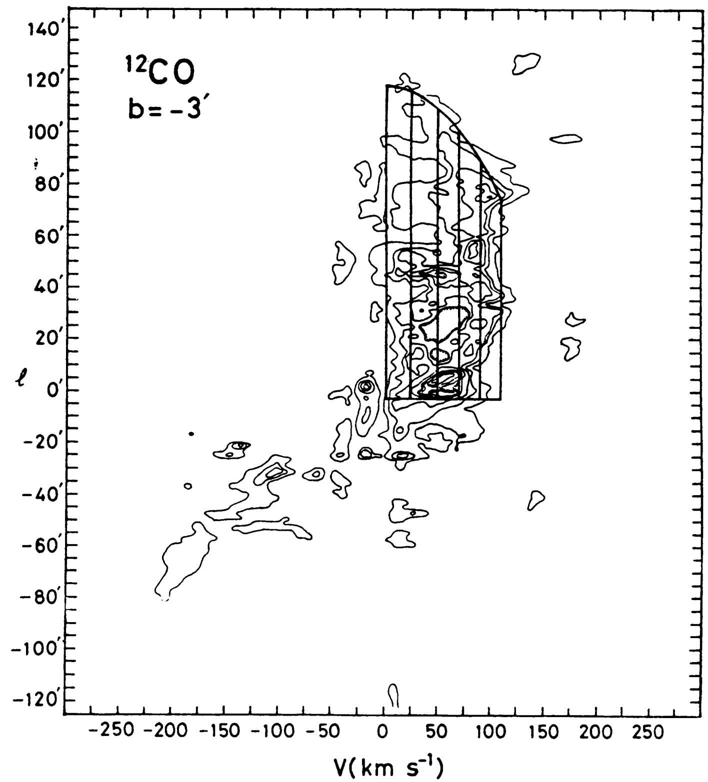


Fig.1(right):The ℓ-v pattern of the fan model(thick line) superposed on the CO map(Liszt and Burton 1978). Contour levels less than 5 K are omitted in the CO map.
Fig.2(left):A schematic view of the fan model. The lower panel shows the top view and the upper the view in the sky. The dashed line is an HI hole suggested by Sanders and Wrixon(1973).

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DISCUSSION FOLLOWING FUKUI

Sandqvist: I am in the process of using the 11m telescope at Kitt Peak to map a 10 arcmin region around Sgr A in the 2-mm H_2CO line. The resolution is about 1 arcmin. Preliminary results reveal a velocity gradient of about 5 km s^{-1} per arcmin in the direction of galactic rotation. Did you observe a similar gradient and did you include galactic rotation in your model?

Ho: We also discovered a strong velocity-gradient across the Sgr A cloud when we mapped the Galactic Center region in the (3,3) line of NH_3. The line shapes are relatively narrow, ∿20 km s^{-1}, shifting by ∿10 km s^{-1} every $1\overset{'}{.}5$.

Fukui: I guess that the strong velocity gradient you observed is in the +30 km s^{-1} cloud, which is located on the negative longitude side of the nucleus. We also observed the same type of velocity gradient there in the HCN emission (P.A.S. Japan, 29, 643, 1977). The +30 km s^{-1} cloud is a minor component of the Sgr A molecular complex, compared to the +50 km s^{-1} cloud at $\ell \gtrsim 0°$, and it is not included in the present model, which aims to explain the predominant emission features. The +50 km s^{-1} cloud shows little sign of rotation according to our HCN and HCO^+ results, and the velocities at the emission maxima are almost uniformly ∿50 km s^{-1} throughout the cloud ($-3' \gtrsim \ell \gtrsim 10'$). Therefore, I did not include strong rotational motion in the model.

Pauls: Your previous HCN survey was also interpreted in terms of a jet model. Is your current model of the CO data consistent with that HCN model?

Fukui: Yes. The present model is just a simple extension of the jet model for the HCN data, and they are consistent with each other.

Liszt: Can you suggest a mechanism for ejecting large quantities of purely molecular gas from a small region near Sgr A at velocities ∿100 km s^{-1}. Acceleration of pre-existing gas would not be a successful explanation, because there is no central hole in your model.

Fukui: I think the acceleration due to cosmic ray pressure, for example, can push the molecular gas outward. The present state of the nucleus does not show strong signs of activity, and it is not clear that sufficient cosmic ray protons are supplied from the nucleus. The strength of the nuclear activity may have decreased significantly over the last ∿10^6 yr, because the anomalous thickness of the +100 km s^{-1} cloud indicates a past active phase of the nucleus, some 10^6 yr ago. The event must be a transient phenomenon. If there were to have been strong acceleration at the earlier phase of the ejection, no additional acceleration would be required.