OH IN THE GALACTIC CENTRE

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ABSTRACT. Preliminary results are reported from an OH mainline absorption study of the galactic centre. The molecular clouds form a well-defined structure 2 kpc in projected diameter, which is warped in its outer regions. The distribution of molecular clouds is highly organised. There are places where the line-widths are anomalously high. The possible nature of these broad-line clouds is briefly discussed.

1. INTRODUCTION

The galactic centre molecular clouds were first detected through their OH mainline absorption at 1665 and 1667 MHz (Robinson *et al*. 1964). These lines still provide a sensitive tracer of molecular clouds in the central region. The OH appears in absorption against the radio continuum emission from the galactic nucleus and the far side of the galactic disc. Comparison between OH absorption and CO emission could therefore give clues to the relative distributions of the molecular clouds and the continuum sources. An extensive survey of the OH mainlines has been carried out at Jodrell Bank using the 250 foot Lovell Telescope (Cohen 1982). In this paper we present some new results from the survey, and discuss the problem of the anomalously broad lines observed from some regions.

2. RESULTS

Figs. 1 and 2 give an overview of the results. Fig.1 shows the distribution of OH absorption integrated over all velocities. The molecular nucleus stands out clearly in this diagram between longitudes $\pm 6^{\circ}$. The preference for positive longitudes is very striking. This asymmetry is also seen in CO emission, which is not affected in the same way by the distribution of radio continuum sources. The outer parts of the molecular layer are warped,

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reaching latitudes of $\pm 1^{\circ}.5$.

Fig.2 shows the velocities of the molecular clouds as functions of longitude and latitude. Fig. 2a shows the OH absorption integrated over all negative galactic latitudes, and Fig.2b shows the OH absorption integrated over all positive latitudes including zero. The velocity scale refers to the 1667 MHz line, which is on the left in these diagrams. The gas associated with the galactic centre dominates Fig.2. Well known features include the Sgr A molecular cloud ($\ell = 0^{\circ}$, V = +40 km s^{-1}), the Sgr B2 molecular cloud ($\ell = 0^{\circ}.7$ V = +60 km s^{-1}) and the 250 pc molecular ring (stretching from $\ell = 359^{\circ}$ V = −130 km s^{-1} to $\ell = 1^{\circ}.4$ V = 0 km s^{-1}). These features all have broad linewidths and cover a large velocity extent. In contrast, foreground material appears as a very narrow line near zero velocity.

In several places very broad lines are seen from regions which appear to be relatively compact. The best known is the feature at $\ell = 3^{\circ}.2$, b = $0^{\circ}.4$ V = 0→200 km s^{-1} discovered by McGee et al. (1970) and designated Clump 2 by Bania (1977). The present survey shows many similar features, including the most extreme example yet at

$\ell = 5^{\circ}.4$, b = $-0^{\circ}.4$ V = −20→200 km s^{-1} and others at
$\ell = 1^{\circ}.4$ b = $0^{\circ}.3$ V = 0→200 km s^{-1}
$\ell = 356^{\circ}.2$ b = $0^{\circ}.8$ V = −120→30 km s^{-1} and
$\ell = 354^{\circ}.4$ b = $0^{\circ}.4$ V = 30→100 km s^{-1}.

In some cases pairs of broadline features seem to be connected at their velocity extrema, to form loops or U-shapes in the ℓ-V plane. Detailed studies of several broadline features have been made using CO emission and H_2CO absorption lines (Stark & Bania 1986; Bania, Stark & Heiligman 1986; Boyce & Cohen, in preparation). These reveal systematic gradients of velocity with position. The broad-line features can be broken down into many smaller clouds which are similar in size and mass to GMCs elsewhere in the Galaxy, but which have broader linewidths (typically 15 km s^{-1} FWHM).

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GREY SCALE FLUX RANGE= -5.0000E-01 2.0000E+03 KELVIN

Fig.1 Grey-scale image of the OH absorption integrated over all velocities. No correction has been made for the distribution of 18 cm continuum emission

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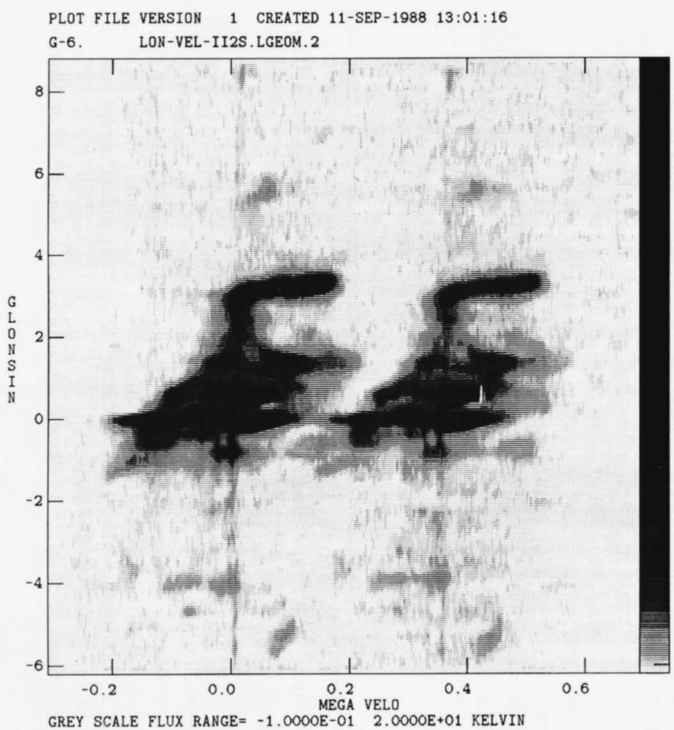

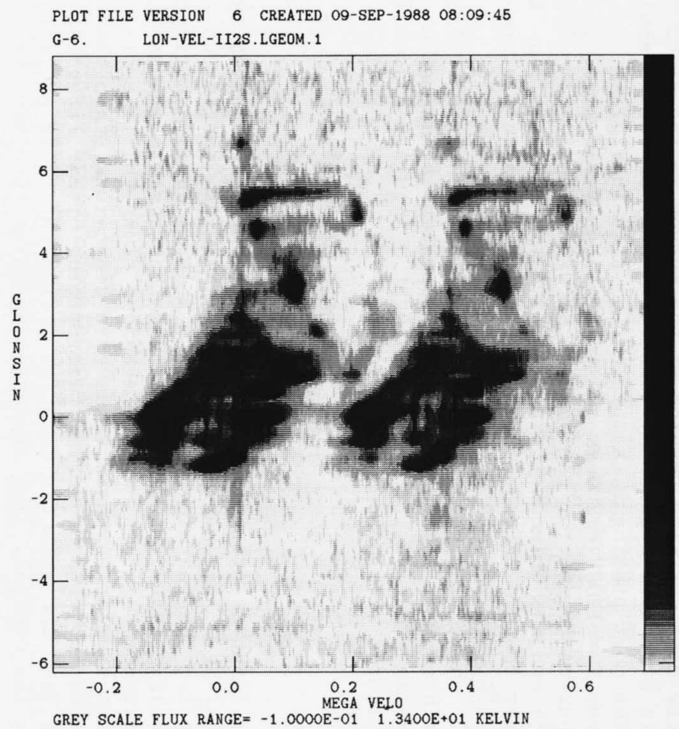

Fig.2a Longitude-velocity map of the OH absorption integrated over positive latitudes, including zero.

Fig.2b Longitude-velocity map of the OH absorption integrated over negative latitudes

One of the most striking results of the survey is the discovery of large-scale structure apparently connecting many of the molecular complexes. The most prominent example can be seen in Fig.2b stretching from $\ell = 1^{\circ}.0$ V = 200 km s^{-1} to $\ell = 5^{\circ}.4$ V = 0 km s^{-1}. In Fig.2a an apparent connection can be seen between Clump 2 ($\ell = 3^{\circ}.0$ V = 20 km s^{-1}) and the molecular ring ($\ell = 1^{\circ}.4$ V = -30 km s^{-1}). In Fig.2a a weaker feature extends from the previously known feature XVI near $\ell = 1^{\circ}.0$ V = 200 km s^{-1} (Cohen & Few 1976) to $\ell = 5^{\circ}.4$ V = 200 km s^{-1} where it appears to join the broadline region. The overall distribution of molecular gas in the nucleus seems to be far more organized than was previously thought. A fuller discussion of these structures will be published later.

3. DISCUSSION

The broadline features are unlike molecular features seen anywhere else in the Galaxy. They have huge kinetic energies, ranging up to 2×10^{54} erg for the feature at $\ell = 5^{\circ}.4$. This is easily sufficient to overcome self-gravity. If the broadline features are as compact as their appearance suggests, with dimensions along the line-of-sight which are similar to their transverse dimensions, then they must be transient objects of very recent origin. Their lifetimes are much less than one galactic rotation period (at their projected distance from the centre). The expansion energies involved are several orders of magnitude greater than could be supplied by a type II supernova.

An alternative possibility is that the features are not compact, but rather result from viewing spiral dust lanes tangentially. In this case the linewidths would reflect the large-scale motion about the galactic centre. The plausibility of this model seems to be weakened by the large number of broadline features which have been detected in the present survey. The model might however offer a natural explanation for the organized structures which appear to connect some of the broadline regions.

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