SEARCH FOR NEUTRAL HYDROGEN WITH HIGH NEGATIVE VELOCITIES EJECTED FROM THE GALACTIC CENTER

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Abstract. A search for neutral hydrogen in the velocity range $-300 > V > -1000$ km s^{-1} has been made in the zone around the galactic nucleus. Observations of 100 points reveal no neutral hydrogen at such high velocities, with brightness temperatures exceeding 0.25 K in the latitude range $|b| < 1,°$ and 0.20 K for $|b| \geq 1°$.

1. Introduction

Astronomical observations in the last few years have shown evidence of violent activity in some galactic nuclei. Of particular interest is the ejection of matter from the nucleus of peculiar, Seyfert, and even ordinary galaxies (Burbidge *et al.*, 1963; Burbidge, 1970).

The idea that highly energetic explosions take place in the nucleus of our Galaxy, and that these explosions may in turn eject matter, is based on several different types of observations.

Radiofrequency observations in the continuum (Jones, 1974), have shown that the core of the radio source Sgr A has a spectrum characteristic of explosive mechanisms. Further, Kerr and Sinclair (1966) observing at 1420 MHz have found two structures emerging from Sgr A, inclined 50° to the galactic plane, and located in the $l > 0°$, $b < 0°$ and $l < 0°$, $b > 0°$ galactic quadrants. These structures may be jets of matter, originating from the galactic center.

An infrared source, with an intensity maximum at 100 μ, and coincident in position with the radio source Sgr A, has been studied by Becklin and Neugebauer (1968, 1969), Low *et al.* (1969) and Hoffmann and Frederick (1969). A thermal interpretation of this infrared spectrum, similar in slope to that found in the nuclei of Seyfert galaxies, poses great difficulties.

On the other hand, radio line observations have given direct evidence of ejection of matter from the galactic nucleus. Scoville and Solomon (1972, 1973) found several molecular clouds near the galactic center with anomalous radial velocities. Part of these clouds were interpreted by Kaifu *et al.* (1972) as a ring expanding with a velocity of expansion $V_{exp} = 130 \pm 5$ km s^{-1}, a rotational velocity $V_{rot} = 50 \pm 20$ km s^{-1} and a radius $R = 270 \pm 30$ pc. The Dwingeloo and Parkes 21 cm line surveys of the galactic

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plane (Rougoor, 1964; Kerr, 1967), have shown the existence of massive structures in expansion from the galactic center.

The 21 cm line surveys outside of the galactic plane also show the existence of features with anomalous radial velocities (Van der Kruit, 1970; Mirabel *et al.*, 1975; Mirabel and Turner, 1975), probably ejected from the galactic center.

Van der Kruit (1971) attempted to explain the anomalous radial velocities of the gas in the central region of the Galaxy invoking recurrent explosive events in the nucleus. These recurrent explosive events must have imparted up to 10^{54}–10^{55} ergs in kinetic energy to the ejected material, as well as initial velocities $|V| > 300$ km s^{-1}, the direction of the expulsion forming an angle greater than 30° with the galactic plane.

The 21 cm line surveys near the galactic center have been made only for $|V| < 300$ km s^{-1}. If we want to confirm the existence of present activity in the galactic nucleus, by means of recently ejected gas at very high velocities, it is necessary to extend the existing surveys of neutral hydrogen over a range of radial velocities greater than $|V| = 300$ km s^{-1}.

2. Observations

For this study, observations were taken at 100 points, covering a 1° grid of the zone $-5° \leqslant l \leqslant +5°$, $-5° \leqslant b \leqslant +5°$, each over the velocity range -300 to -1000 km s^{-1}.

The observations were made with the 30 m radiotelescope at the Instituto Argentino de Radioastronomía located in Parque Pereyra Iraola, Province of Buenos Aires, Argentina. The receiver uses a front end with a parametric amplifier of 10 MHz bandwidth and 30 channels, 100 KHz wide, spaced 100 KHz. Each observation in the 21 cm line covers a velocity range of 750 km s^{-1} with a velocity resolution of 25 km s^{-1}. The observed radial velocities were reduced to the local standard of rest. Each point was observed at least two times with a total integration time of at least 12 min. The system noise temperature is close to 250 K. In practice, however, due to long period instabilities in the receiver, the minimum detectable temperature is about 0.20 K for 20 min integration time, out of the galactic plane. For points with $|b| < 1°$, because of the greater contribution of the galactic continuum, the minimum detectable temperature is higher, about 0.25 K.

A calibration profile was taken each hour with a noise tube of 10 K. From each profile of the program we subtracted a 'profile without hydrogen', taken along with the calibration every hour. At the beginning of the observations we have arbitrarily chosen the points at $l = +5°$, $b = -5°$; $l = -5°$, $b = +5°$, as 'profiles without hydrogen'. Since no systematic negative temperature deflection was found for any of the reduced profiles of the program, we may indeed infer that no neutral hydrogen with temperatures greater than 0.20 K and with velocities between -300 and -1000 km s^{-1} is present at the points selected as 'profiles without hydrogen'.

3. Results

No neutral hydrogen with radial velocities in the range -300 to -1000 km s^{-1} and

temperatures in excess of 0.20 K for $|b| \geq 1°$, and 0.25 K for $|b| < 1°$ was found for any of the 100 points observed.

This negative result is in apparent contradiction with other evidence for current activity in the galactic nucleus. We may interpret our result in two principal forms. Firstly, the galactic nucleus may, at present, be in a period of inactivity or else in a state of activity lacking the sufficient energy to eject matter with velocities greater than $|V| = 300$ km s^{-1}. Secondly, the matter recently ejected from the galactic nucleus with very high velocities can be in a physical state other than neutral hydrogen (ionized or molecular state). In order to distinguish between these two hypotheses it would be of great interest to make recombination and molecular line surveys outside the galactic plane in an anomalous radial velocity range.

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