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14. Abstract/Notes – *In August 1979 started the build up of a new water maser source in Orion[1,2]. Due to its proximity, it became the strongest source in the sky. The maser was first detected in the VLBI experiment conducted by Genzel et al.[3] in June 1979. The 8 km s^{-1} feature belongs to a group of maser sources expanding with a velocity of 18 km s^{-1} from a centre that coincides with the infrared source IRc2. During the period of maximum activity, between October 1979 and Ausut 1980, the flux density reached the value[4] of 2.3×10^6 Jy. The high degree of linear polarization (30-60%) put some constraints on the physical parameters of the maser. We report in this letter the discovery of a new rapidly recurring outburst[5] in October-November 1983 with time scales of variation shorter than 5 hours. We present also single dish observations of this source during the past four years and we discuss a model of the flaring region that is consistent with the results of interferometric observations[6].*

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THE OCTOBER 1983 RECURRENCE OF THE OUTBURST OF THE ORION WATER MASER SOURCE AND ITS PAST HISTORY

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In August 1979 started the build up of a new water maser source in Orion[1,2]. Due to its proximity, it became the strongest source in the sky. The maser was first detected in the VLBI experiment conducted by Genzel et al.[3] in June 1979. The 8 km s^{-1} feature belongs to a group of maser sources expanding with a velocity of 18 km s^{-1} from a centre that coincides with the infrared source IRc2. During the period of maximum activity, between October 1979 and August 1980, the flux density reached the value[4] of 2.3×10^6 Jy. The high degree of linear polarization (30-60%) put some constraints on the physical parameters of the maser. We report in this letter the discovery of a new rapidly recurring outburst[5] in October-November 1983 with time scales of variation shorter than 5 hours. We present also single dish observations of this source during the past four years and we discuss a model of the flaring region that is consistent with the results of interferometric observations[6].

Genzel et al.[3] suggested that the Orion water vapor maser radiation is anisotropic, and that the observed flaring-up may be caused by the maser beam happening to point in our direction. Matveenko[7] reported the results of observations with the Crimea-Pushchino radio-interferometer, which suggested the existence of several sources of sizes smaller than 0.2 AU. Another VLBI experiment[6] between the antennas of Haystack-Green Bank and Crimea-Effelsberg, in November 1979, suggested the existence of a compact core of 0.25 AU embedded in an extended halo of 3AU in diameter. Sixty five percent of the radio flux (1.1×10^6 Jy) would arise from the compact source and the rest (6×10^5 Jy) from the extended one.

The observations reported here were made at the Itapetinga Radio Observatory with the 13.7 m radome-enclosed radio-telescope. The resolution of the antenna at 22 GHz is 4 arc min. The receiver consists of a room-temperature K-band mixer and a 100 kHz filter bank, with a system temperature of 1000K. We operated in the beam-switching mode, between two rectangular horns, separated in azimuth by 20 arc min. One of the horns is sensitive to the vertical E vector and the other to the horizontal E vector. We therefore obtained simultaneously the two components of the linearly polarized flux by making scans in azimuth through the source, with an amplitude of 90 arc min and duration of 30s. Each observation consisted of the average of six scans. The system was calibrated before each observation, by using a room temperature load. This method automatically corrects for atmospheric attenuation[8], even in the presence of a radome[9]. The transformation from antenna temperature to flux density was calculated by assuming that the flux density of Virgo A was equal to 21.5 Jy for the 22 GHz continuum. Since we could not resolve the water maser line with the 100 kHz filter bank, we corrected the flux density by assuming a width of 30kHz for the line[4].

In Fig. 1 we present the time behaviour of the flaring water maser feature in Orion. The flare reported here started sometime between June and October 1983. The short time structure, with period of about 10 days was not observed during the previous flare. During the active periods (1979-1980 and 1983), the flux density reached 2.3 x 10^6 Jy and 2.8 x 10^6 Jy respectively. In the quiescent period the flux density remained high and at about 5 x 10^5 Jy.

In Fig.2 we present the short time behaviour of the source. This was the only case in which strong variability was found during the several hours in which the source was observed every day. Fluctuations of the signal of less than about 10% are not considered.They are attributed to variations in atmospheric transmission, small departures from linearity in the receiver and small differences in the gain of the two horns. The short time scale fluctuations of the data of November 15, 1983 are much larger than this value,we observed also a systematic increase in the flux density from 1.1 x 10^6 Jy to 1.7 x 10^6 Jy during a period of five hours.

In terms of the two component model suggested by the VLBI observations[6], we can interpret the long time scale behaviour of the burst source as due to the superposition of the contributions of a compact source in the form of a disc and that of an extended halo. During the quiescent period, most of the radiation would come from the halo, the observed flux density coincides with the value found by Matveenko et al.[6]. During the active periods (October 1979 - August 1980 and since October 1983) the disc would present itself edge on, contributing to a large part of the flux density. The oscillations of the flux density during the 1983 outburst with time scales of about 10 days can be interpreted as the appearence of individual clouds or irregularities as the plane of the disc rotates.

Assuming the width of the disc as 0.25 AU[6], and using the fact that it is visible for about 150 days, the observed fluctuations with periods of 10 days imply a dimension of 0.02AU for the individual clouds. The fast fluctuations observed during November 15, 1983 (Fig. 2) would occur at the boundary of the cloud.

Of course, the long and short time fluctuations in the emission could also be attributed to variations in the physical conditions of the emitting regions. However, we have also observed a periodic behaviour in the polarization angle, that seems to confirm the first assumption. A more detailed study of the model explaining this periodicity is now in progress and will be the subject of another publication. A complete description of the phenomena would require interferometric observations of the source during the different phases of activity. Such data would be very helpful to decide between the different models.

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REFERENCES

1. Abraham, Z., Opher, R., and Raffaelli, J.C. IAU Circular No. 3415 (1979).
2. Matveenko, L.I., Kogan, L.R., and Kostenko, V.I. *Sov.Astron.Lett.* 6, 279-281 (1980).
3. Genzel, R., Reid, M.J., Moran, J.M., and Downes, D. *Astrophys. J.* 244, 884-902 (1981).
4. Abraham, Z., Cohen, N.L., Opher, R., Raffaelli, J.C., and Zisk, S.H. *Astron. Astrophys. (Letters)*, 100, L10-L13 (1981).
5. Abraham, Z., and Vilas Boas, J.W.S. IAU Circular No. 3879 (1983).
6. Matveenko, L.I., Moran, J.M., and Genzel, R. *Sov.Astron.Lett.* 8, 382-383 (1982).
7. Matveenko, L.I., *Sov. Astron. Lett.* 7, 54-57 (1981).
8. Ulich, B.L., and Haas, R.W., *Astrophys.J.* 30, 247-258 (1976).
9. Abraham, Z., Medeiros, J.R., and Kaufmann, P., *Astron.J.* (in press) (1984).

FIGURES CAPTIONS

Fig. 1 - Time behaviour of the 8 km s^{-1} water maser source in Orion. Days are counted from August 1, 1979.

Fig. 2 - Short time fluctuations in the 8 km s^{-1} water maser source in Orion. Observations are separated by approximately 6 min.

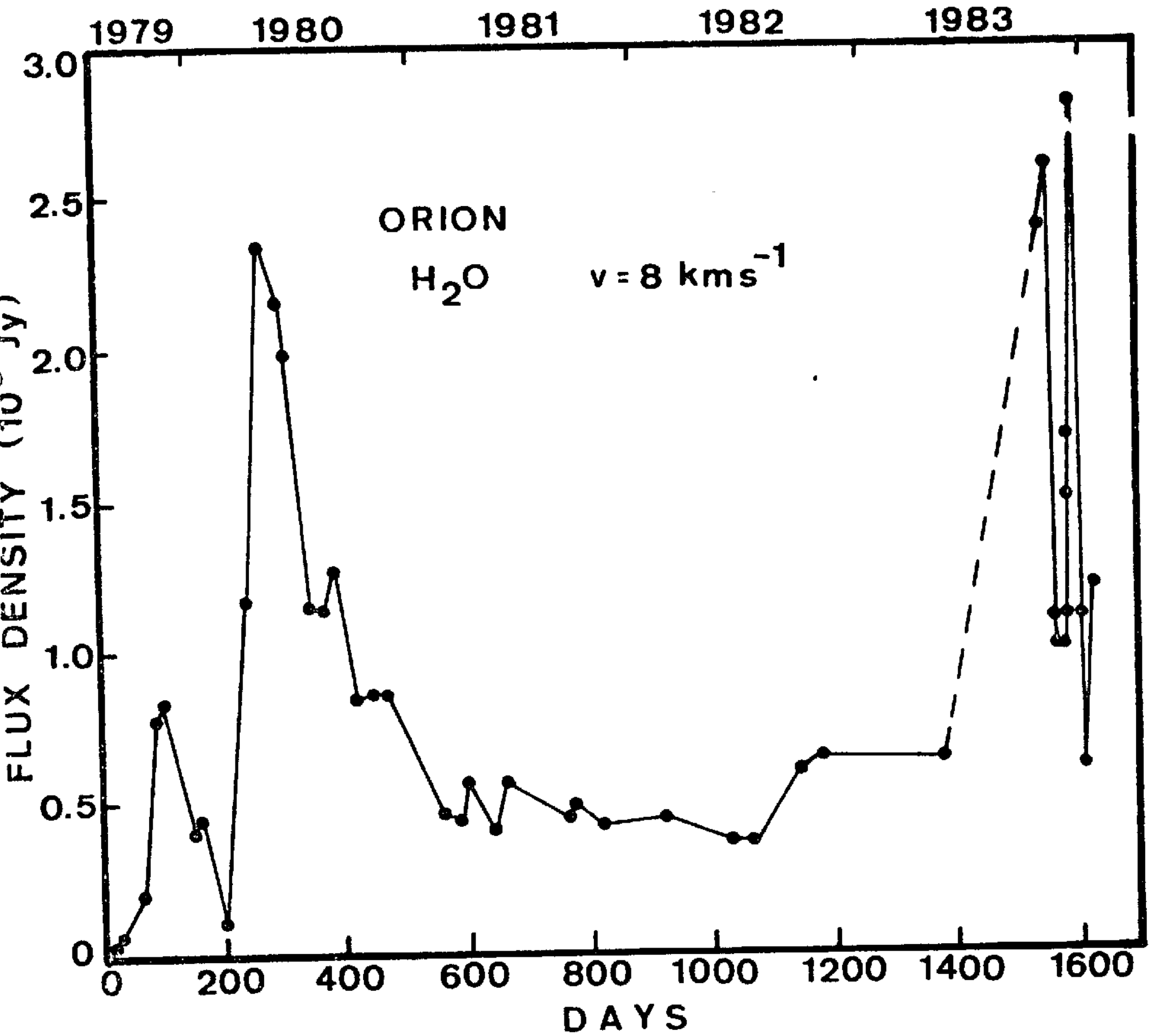
1979
1980
1981
1982
1983
ORION
H_2O
v = 8 kms^{-1}
FLUX DENSITY (10 Jy)
3.0
2.5
2.0
1.5
1.0
0.5
0
0
200
400
600
800
1000
1200
1400
1600
DAYS

Fig 1

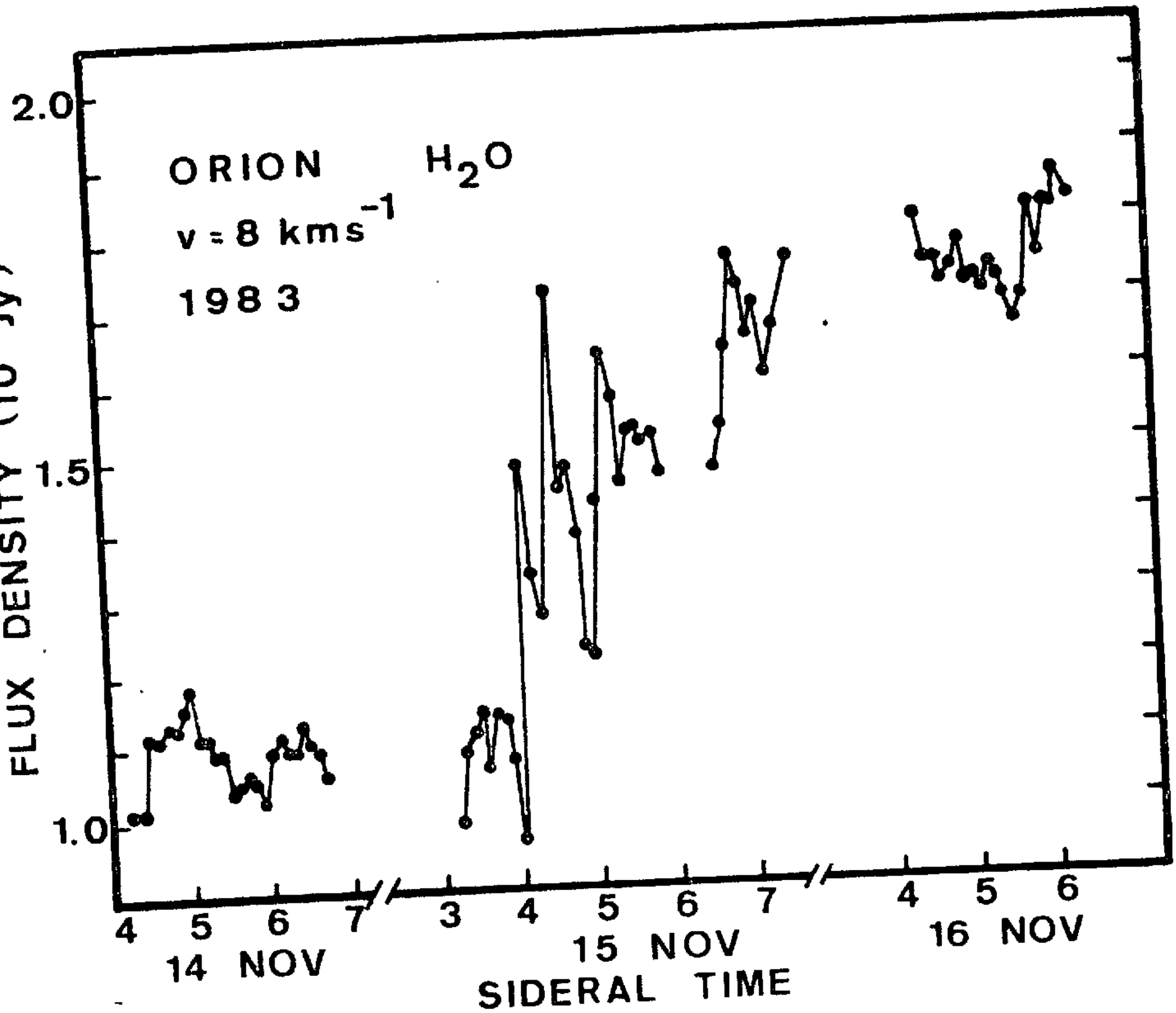
ORION H_2O
v = 8 kms^{-1}
1983
FLUX DENSITY (10^6 Jy)
2.0
1.5
1.0
4 5 6 7
14 NOV
3 4 5 6 7
15 NOV
4 5 6
16 NOV
SIDERAL TIME

Fig 2