*Cosmic Masers - from OH to $H_0$*
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# Chasing the flare in Orion KL: Observations of the 22 GHz $H_2O$ Masers at HartRAO

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**Abstract.** The work here represents the summary of observations made with the Hartebeesthoek Radio Astronomy Observatory (HartRAO) 26 m telescope of the water vapour ($H_2O$) Masers in the Orion KL source region for a period of 8 months during the flare of 2011. The observation setup, calibration method together with the resulting maser time series are discussed.

**Keywords.** masers, ISM: individual (Orion KL), radio lines: ISM

## 1. Background

The source of interest discussed here is the $H_2O$ maser in the Orion KL (Kleinman-Low) nebula source region (Reid *et al.* 1981). Flares in this region from the 1.35 cm wavelength water maser emission line occurred during the period of 1979–1985, with a second flare in 1998 (Tolmachev 2000). The previous flares were very intense, increasing in flux density from around hundreds to millions of Janskys. A new flare was reported in 2011 (Tolmachev 2011) and it was decided to use this to test the performance of the new 22 GHz receiver on the 26m Hartebeesthoek telescope.

## 2. Observation setup

The 26 m radio telescope at HartRAO was used with the experimental 1.3 cm receiver to make spectral line observations of the water masers in Orion KL at a centre frequency of 22235.12 MHz and 8 MHz bandwidth. Radio continuum observations at the same centre frequency but with 32 MHz bandwidth were made of Jupiter over the same period to assist in calibration. The observations were made from the time period of 12 March 2011 to 22 November 2011, at 05 32 46.6 and (1950) −05 24 27.2. The antenna half power beamwidth at this frequency is 0.035 degrees, with the spectrometer velocity resolution being 0.105 km.s$^{-1}$ per channel and the centre velocity 10 km.s$^{-1}$.

## 3. Data reduction

Jupiter was used as the calibrator source as it has a constant brightness temperature of 136 K at 22 GHz (Gibson *et al.* 2005, Hill *et al.* 2009). Drift scans were done on this source and the resulting observed antenna temperatures were corrected for various factors including pointing, angular size, focus offset and atmospheric absorption corrections. The maser spectral line observations were done using the position switching method. To determine the pointing correction, spectra were obtained at the half power points of the beam in the North, South, East and West directions. Bad data were removed; these were due to bad weather, high system temperature or large errors in pointing. Corrections for atmospheric absorption were then made using water vapour measured

by GPS after which the data were converted to flux densities using the results from the Jupiter calibration.

## 4. Results

The average total intensity spectrum (lcp and rcp added) of the reduced 2011 maser data is given by Fig. 1, together with HartRAO data from 2007 overlain. It is clear that some of the maser peaks are flaring. The highest peak is at $V_{lsr}$ = 7.893 km s$^{-1}$ (A) reaching an average of over 80,000 Jy total intensity, with the second and third brightest peaks at $V_{lsr}$ = 7.367 km s$^{-1}$ (B) and $V_{lsr}$ 12.107 km s$^{-1}$ (C) respectively. This can be compared with Hirota *et al.* (2011) who found two main maser features flared during the period of March to May 2011, at 7.58 km s$^{-1}$ and 6.95 km s$^{-1}$.

Time series plots of the maser data (lcp) were made for the main feature velocities as well as for other weaker peaks are shown in Fig. 2. Some of the features show an increase in flux density stretched over a long period of time as seen at $V_{lsr}$ = −30.102 km s$^{-1}$ and peak B, with $V_{lsr}$ = −6.642 km s$^{-1}$ having a shorter burst in intensity and an average intensity of ∼50 Jy at other times.

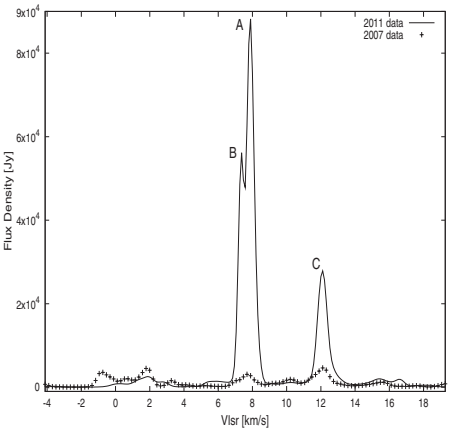


**Figure 1.** Average total intensity spectrum of the $H_2O$ Masers in Orion KL from 2011 with 2007 data overlain.

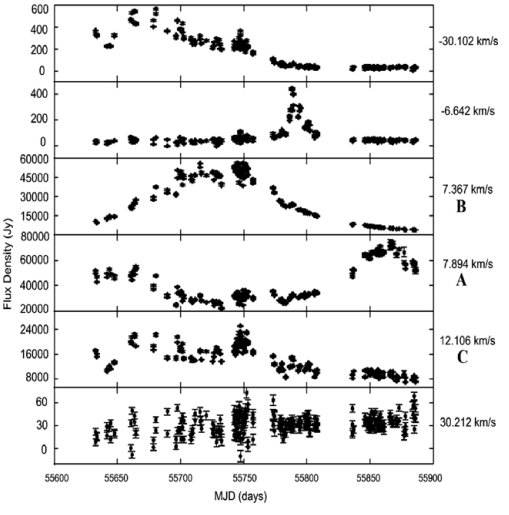


**Figure 2.** Light curves (lcp) of the $H_2O$ Masers in Orion KL at the peak and other weaker velocities.

Altough flaring clearly occured during this period of 2011, the flux density has not yet increased to values comparable to that of the previous flares. Continued observations will reveal more of the behaviour of these water masers.

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