Studying High Mass Star Forming Regions Through Radio Emission Lines

Khafagy, E.A. — Cairo Uni. Egypt
Edris, K.A. — Al-Azhar Uni. Egypt
Richards, A.M.S. — Manchester Uni. UK
Shalabiea, O.M. — Cairo Uni. Egypt
Awad, Z. — Cairo Uni. Egypt
Fuller, G.A. — Manchester Uni. UK

Motivation

Studying high mass stars has great importance in the field of Astronomy and Astrophysics. They influence galaxies' formation and supply the universe with heavy elements. They are found at great distances inside dusty dense clouds, making it difficult to study their formation in optical bands (Fig. 1). So, in this study we trace high mass star formation by observing one of the indicators of their presence, the Laser brother in the radio band, Microwaves Amplification by Stimulated Emission of Radiation (MASER). The strong and compact nature of MASER sources makes them good tracers of material surrounding pre-stellar cores and their physical properties and morphology.

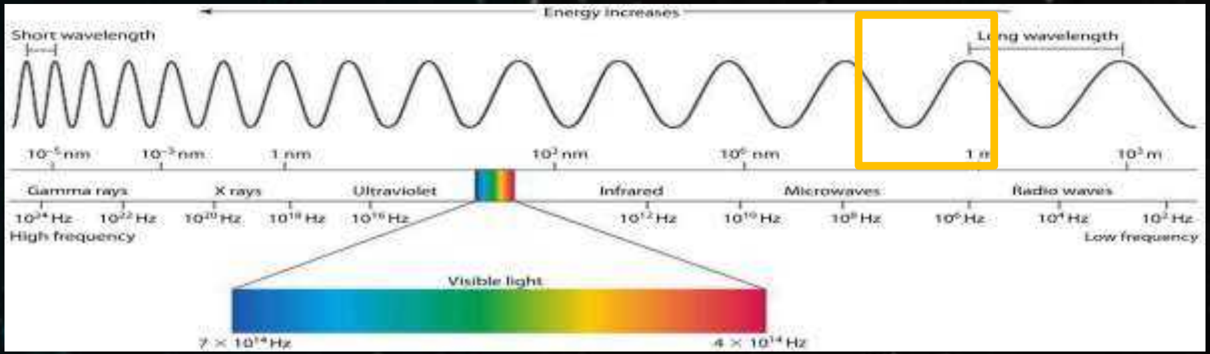

Figure 1. shows the different bands of electromagnetic radiation. while most the known astronomical observations are carried in the optical band, our observations were carried in the Microwave band (boxed) which is part of the radio band, which includes the longest wavelengths and weakest energies.

Aim of Study

Our main aim is to use maser emission to trace the early evolutionary stages of high mass stars in order to build understated how they form and build a classification for high mass star forming objects to figure out their stages of revolutionary process.

Contact Info.
E-mail:
esraakhafagy@gstd.sci.cu.edu.eg

LinkedIn:
https://www.linkedin.com/in/israa-khafagy-b53270106/

MANCHESTER 1824 The University of Manchester

Target Object

We used Infrared (IR) radiation intensity to choose an object that is expected to be a forming massive star in its early evolution. Our target object (IRAS 18144-1723) is taken from the Infrared Astronomical Satellite catalogue. It has an IR intensity similar to those with ionized Hydrogen HII, a sign of the presence of a Proto-star with radiation ionizing its surrounding. However, we have not yet detected an HII region toward this object, so we suppose that it is in earlier stage than other sources with HII regions.

Observations

The maser used in this study is methanol (CH_3OH) maser and the observation was done by the Multi-Element Radio Linked Interferometer Network (MERLIN) which is an interferometer array of radio telescopes spread across England. This allows the study of sources which need a higher angular resolution than that achieved by using a single dish telescope.

The 6.7 GHz methanol line was observed in a spectral bandwidth of 0.25 MHz centred at a gas velocity of 56 km/s with respect to the Local Standard of Rest.

What did we get?

We detected a total of 52 maser components of the 6.7 GHz methanol maser towards IRAS 18144-1723 which were grouped according to spatial and spectral distribution and averaged into 9 features (Table 1). Figure (2) shows the 6.7 GHz Methanol maser Spectrum with the features labelled as in Table 1. The strongest maser feature has velocity of 51 km/s. Varricatt et al. (2010) present a H_2 image showing a bowshock-like feature about 18" to the west of the IRAS position. Gomez-Ruiz et al. (2016) observed methanol masers at 44 GHz and detected 11 maser spots. Nine of their detected maser spots fall in a bunch within ~5 arc-sec of the bow shock, seeming to trace a shock from a deeply embedded object. Our observations at 6.7 GHz detected 9 methanol maser features located more than 1 arcsecond north of the 44 GHz maser. In a more recent study, Varricatt et al (2018) used near infra-red imaging to find two embedded sources defined as A & B (Figure 3). A is well detected in K-band (2.2 micron) whilst source B is weak. The 6.7 GHz Methanol maser is associated with the weak K-band source B (figure 3).

F	Vlsr	Flux density
	Km/s	Jy/Beam
1	51.85	1.52 ± 0.01
2	51.07	7.60 ± 0.03
3	49.57	6.33 ± 0.03
4	48.90	3.22 ± 0.02
5	50.30	1.80 ± 0.02
6	49.57	1.62 ± 0.03
7	47.51	0.94 ± 0.02
8	47.21	0.32 ± 0.02
9	45.54	0.19 ± 0.01

Table 1. list of the features of 6.7 GHz methanol masers with their velocities, and flux densities

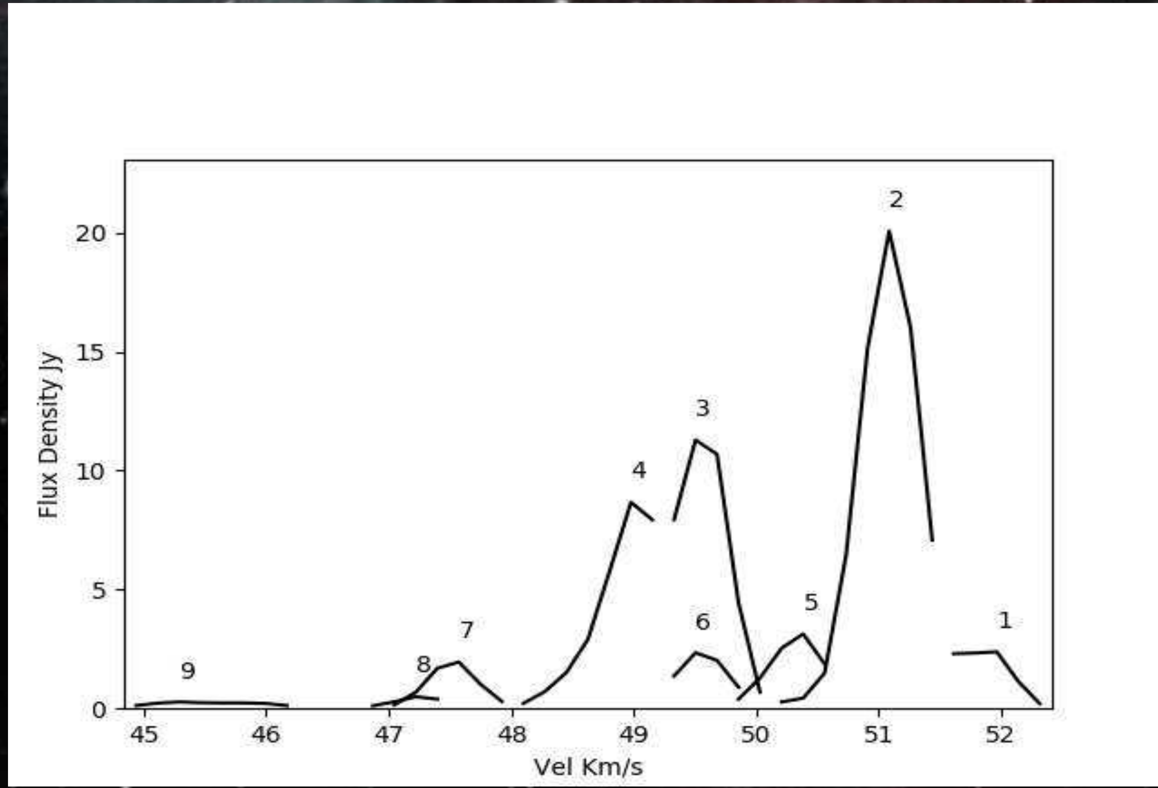

Figure 2. shows the 6.7 GHz methanol spectrum with the features labeled as in Table 1. The strongest maser feature has velocity of 51 Km/s.

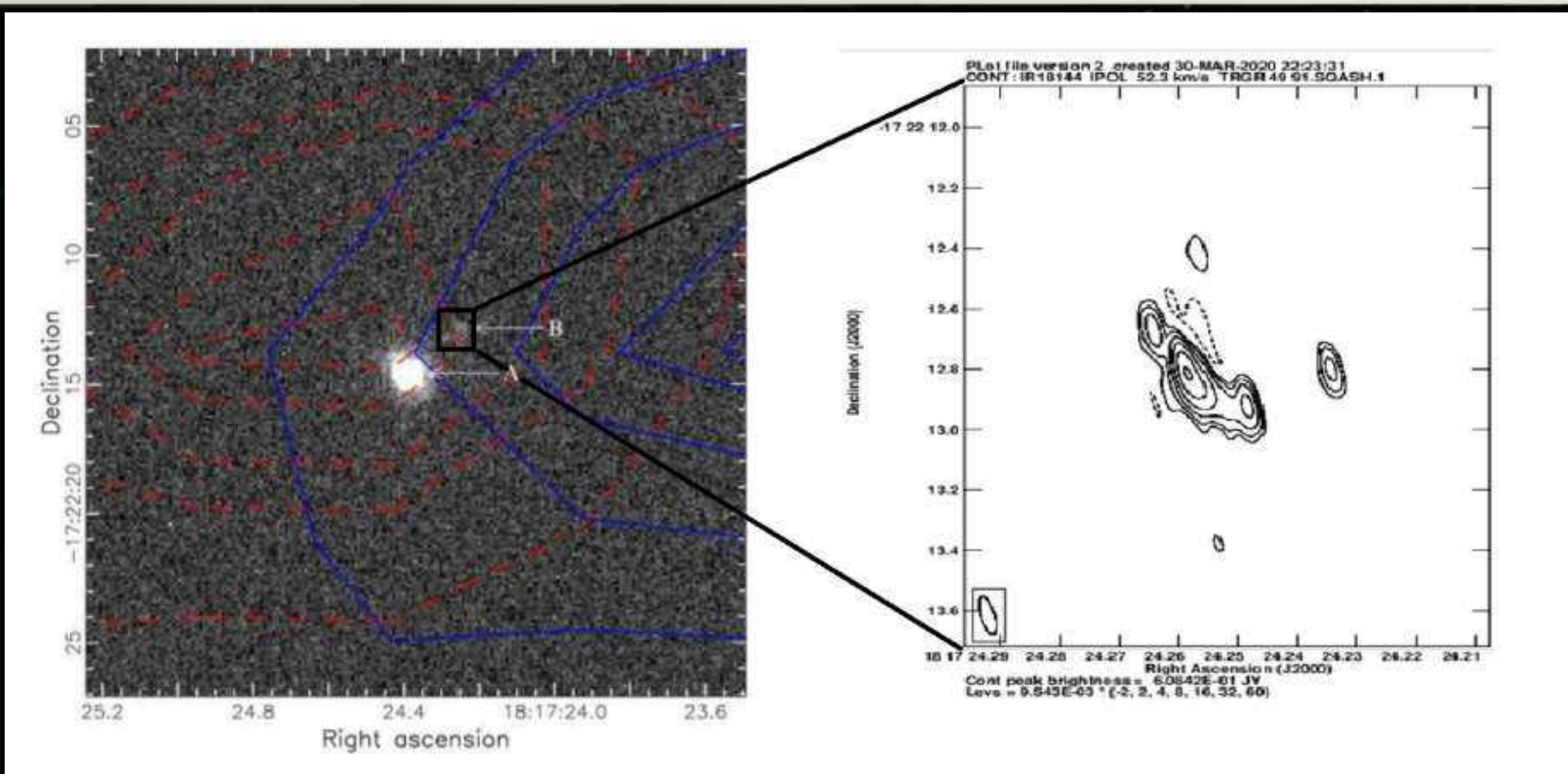

Figure 3. Left panel shows the IR source A & B detected by Varricatt et al (2018) where the blue and red contours are generated from the integrated CO(3-2) maps of the red and blue shifted lobes of the outflows. Right Panel shows the contour lines of integrated 6.7 GHz methanol maser emission towards our target source. It shows that the 6.7 GHz Methanol maser position is consistent with the weaker IR source, B.

Conclusion

We detected 9 maser features of 6.7 GHz methanol towards the region of IRAS18144-1723. The strongest maser feature of 20 Jy is at velocity 51 km/s. The detected maser features are close to the weaker IR K-band source which indicates that they are associated with a proto-star in an earlier stage of its evolution that the strong IR source to the east.

References

Gomez-Rutz, A.I, Kurtz, S.E., Araya, E.D., Hofner, P., Loanard, L. 2016, ApJS 222, 18

Varricatt, W.P., Davis, C.J., Ramsay, S.K., Todd, S.P. 2010, MNRAS, 404, 661

Varricatt, W.P., Wouterloot, J.G.A., Ramsay, S.K., Davis, C.J. 2018, MNRAS, 480, 4231