Q1 What are the 3 major factors influencing the observed brightness of maser emission

Q2 What is the main source of pumping energy for the following maser species (radiation or collisions)
- 22 GHz water maser
- 6.7 GHz methanol maser

Q3 If you want to investigate the jets of protostars, which of the above masers would be the most suitable observational tool? Why

Q: In a hypothetical VLBI observational investigation of a protostar with a bipolar jet, two clusters of water masers are found with coordinates:

Cluster 1 $x, y = 0, 40$ mas ← (milliarcsecond)

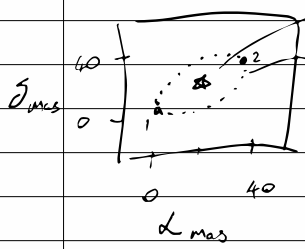
Cluster 2 $x, y = 60, 100$ mas

Q: Assuming these trace shocks in a protostellar jet, what are the x, y coordinates of the protostar which is launching the jet?

Q: If the protostar is at a distance of 5 kpc what is the physical length of the jet in units of AU?

Q: If the masers are moving with a proper motion of 2.5 mas/yr, how long ago was the jet launched?

Q In another hypothetical VLBI campaign of a high-mass protostar a ring of 6.7GHz methanol masers was found, their appearance was as follows:



The line-of-sight velocities of the masers marked 1 and 2 are

$V_{LSR1} = -10 km/s$

$V_{LSR2} = +10 km/s$

If the distance to the protostar is 2kpc and the inclination of the disk is 30° away from being edge-on, calculate the mass of the protostar, assuming that the disk has Keplerian rotation w.r.t.:

$$V_{rot} = \sqrt{\frac{GM}{r}}$$