JWST Peers into the Class I Protostar TMC1A: Atomic Jet and Spatially Resolved Dissociative Shock Region

With the advent of JWST, astronomers and astrophysicist wonder if there is new light that can be shed on previously well studied phenomena like protoplanetary or prostellar disks. At least the astrophysicists of this paper are strongly leaning that way, with research that backs it up. This paper in particular focuses on protostellar disks and their outflows. But what exactly is protostellar outflow, and why is important to this research? Outflow, and more specifically polar outflow, is when both poles of a star shoot out a continuous jet of gas. Outflows are important for at least two reasons, one is because they are typically easier to observe than other related phenomena, and the second because they can impact planet formation within a protostellar disk, which in turn impacts the evolution of the disk. Additionally, outflows should be detectable in infrared and sub millimeter wavelength ranges. This is where TMC1A and JWST come into the picture. TMC1A is a prostar with a mass of about 0.45 that of our sun. It also has a bipolar outflow of carbon monoxide which was measured to be around 6000 AU. JWST's part allowed us to map the atomic and molecular gas of wavelengths 0.9-5 microns surrounding TMC1A. But how did it do that?

It turns out that JWST has something called Near Infrared Spectrograph (NIRSpec), more specifically NIRSpec integral field unit (IFU). This allows for spatially resolved imaging spectroscopy, which provides resolution from 0.97-5.28 microns. However the paper only focuses on 0.97-2 microns because that is where a good deal of atomic lines are detected. JWST also used the Wide Aperture Target Acquisition for target acquisition, and data involving this things was read by NRSRAPID (a NIRSpec readout). While JWST was what was used for taking data, the National Institute of Standards and Technology was used for its data on atomic spectra and the van Hoof line list, to compare transitions for H, He, O, and Fe. Which bring us to, what did JWST and the researchers find?

It turns out that the observations from the JWST showed spectrally resolved atomic and molecular lines, between 1-5 microns, as well as detecting broad atomic emission lines. Using the integral field unit, the researchers using JWST, were able to see linearly extended emission in the direction of outflow, traced by Fe II (Iron 2) and H2 (hydrogen 2). And based on broad line profiles, it is assumed that the outflow was the dominant source of emission. Future work on this, either from the author or others, will be to determine if the outflow from TMC1A is consistent with proposed launching mechanisms (a different can of worms for another time).