Radio Emission From Protostellar Jets in Perseus Molecular Cloud Compared With Water Line Luminosities

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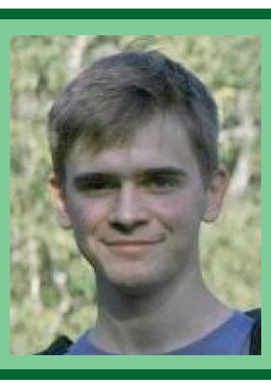
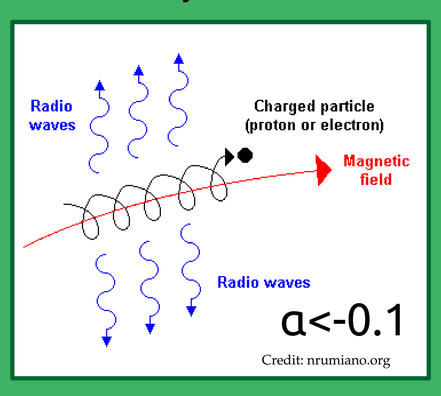


Motivation

- We present the VLA C-band observations from the VANDAM survey (Tobin et al. 2015) of all protostars in Perseus;
- We check whether the radio emission is related to the water and oxygen from Herschel; those are important gas coolants originating from the jet/outflow shocks (Karska et al. 2013);
- By calculating disk masses and spectral index maps, we investigate the nature of radio emission and physical properties of the protostars.

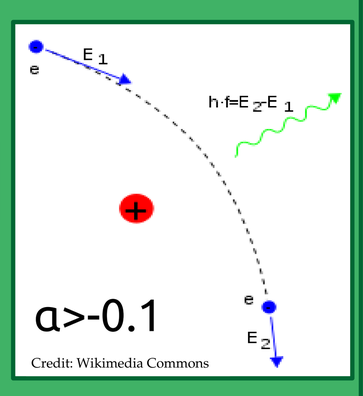
Nature of radio emission

Synchrotron



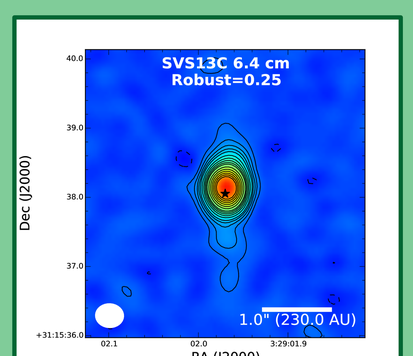
$S_\alpha \sim \nu^\alpha$

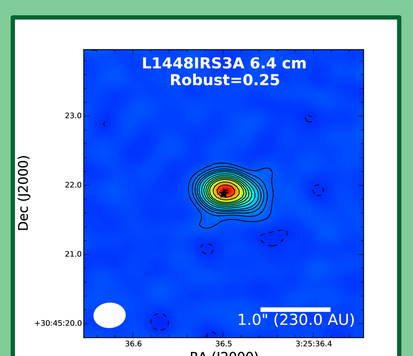
Free-free

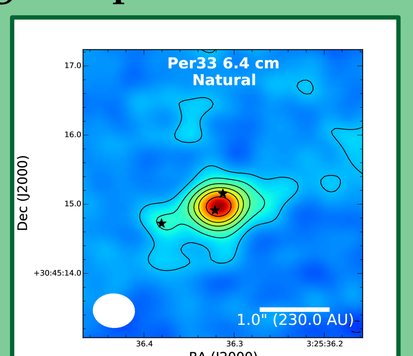


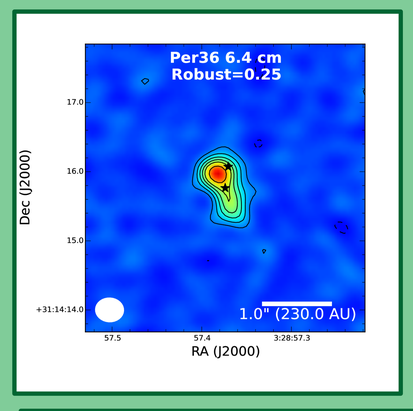
Radio emission can trace different processes in protostars. Spectral index can discriminate between them.

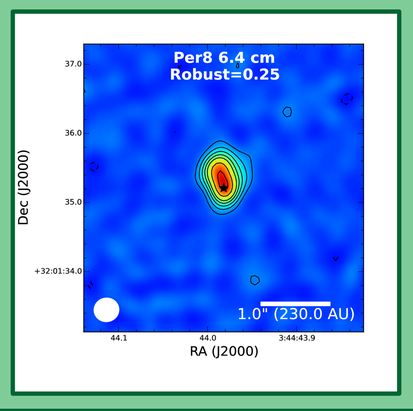
Extended emission in VLA 6.4 cm images of protostars

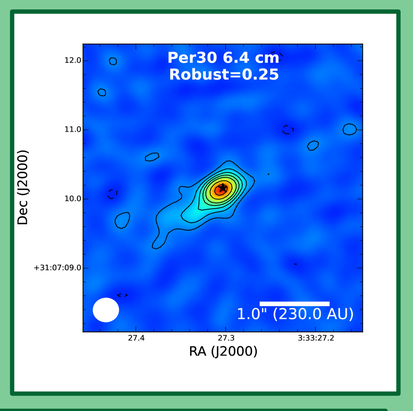






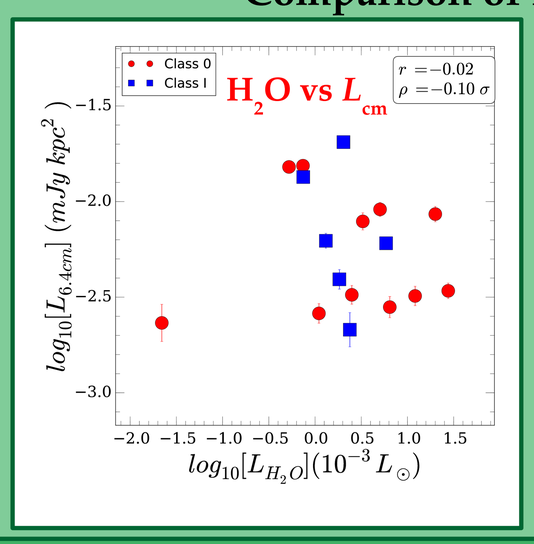


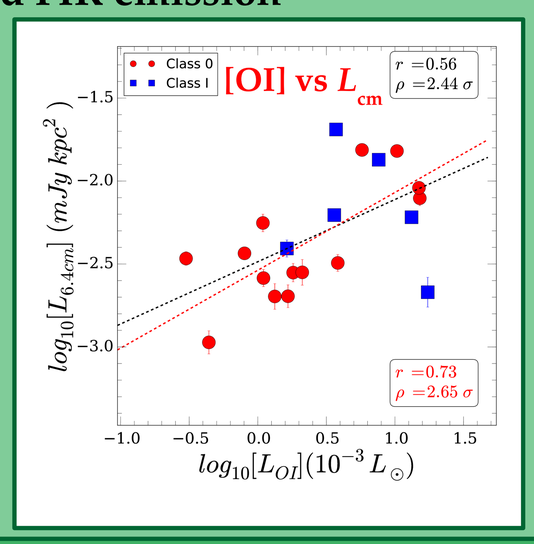




7 out of 60 detected sources exhibit extended emission at 6.4 cm. The extent of these structures often matches the outflow directions from the infrared scattered light and CO outflow data.

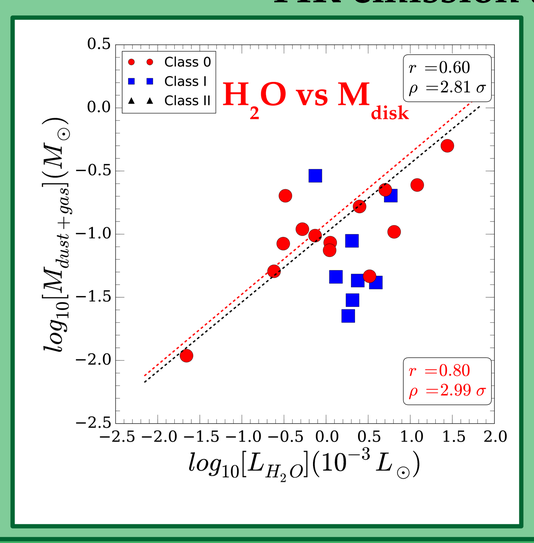
Comparison of radio and FIR emission

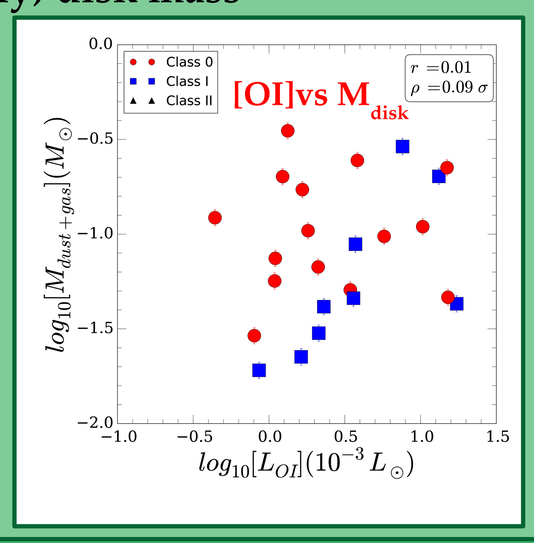




There is no correlation between water luminosity and L_{cm} emission. Weak correlation with the [O I] 63 μm emission tracing dissociative shocks in the jet is detected. Class 0 sources show stronger correlation

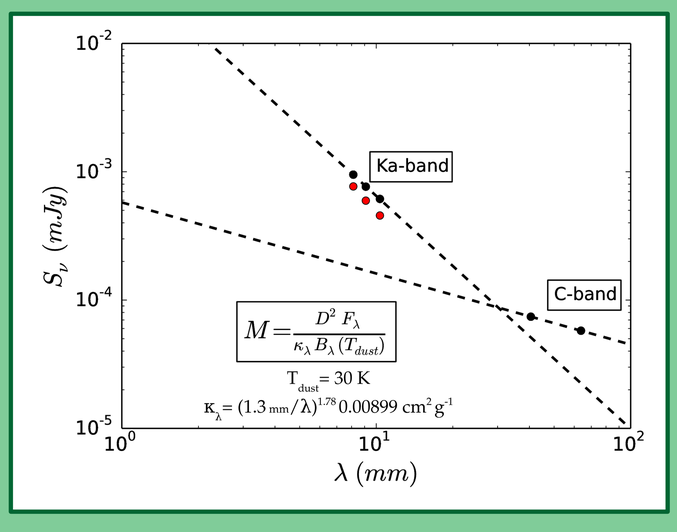
FIR emission and (early) disk mass



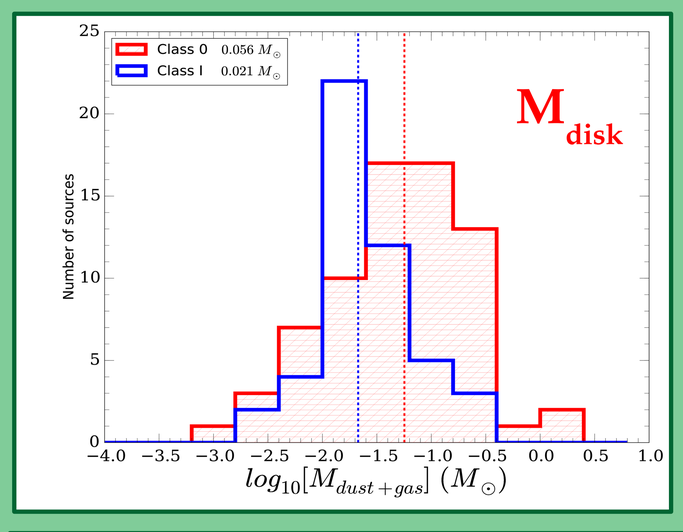


Water line luminosity increases for sources with greater disk (gas + dust) masses. Correlation is higher for the Class 0 sources. Lack of correlation between the disk mass and [OI] 63 μm emission.

Disk mass determination

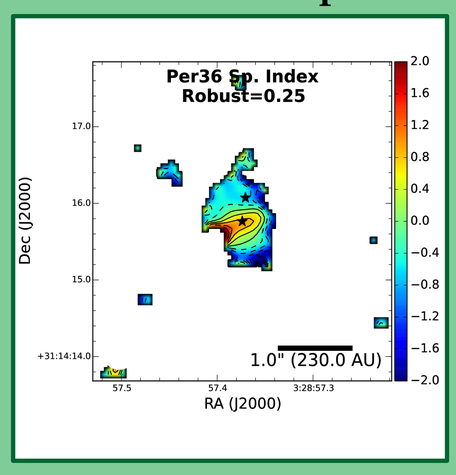


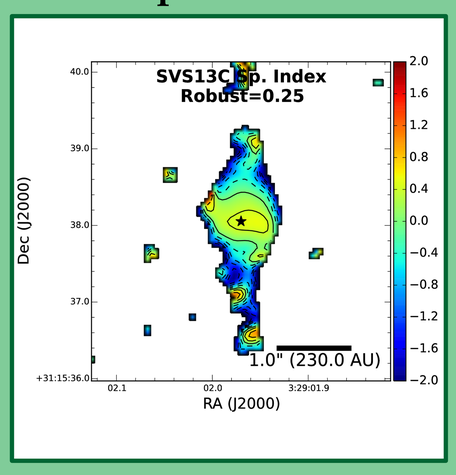
Estimated free-free component was substracted from Ka-band flux to obtain dust-only flux.



Median dust and gas masses for Class 0 and I protostars indicate an evolutionary trend towards lower masses for more evolved sources.

Spectral index maps



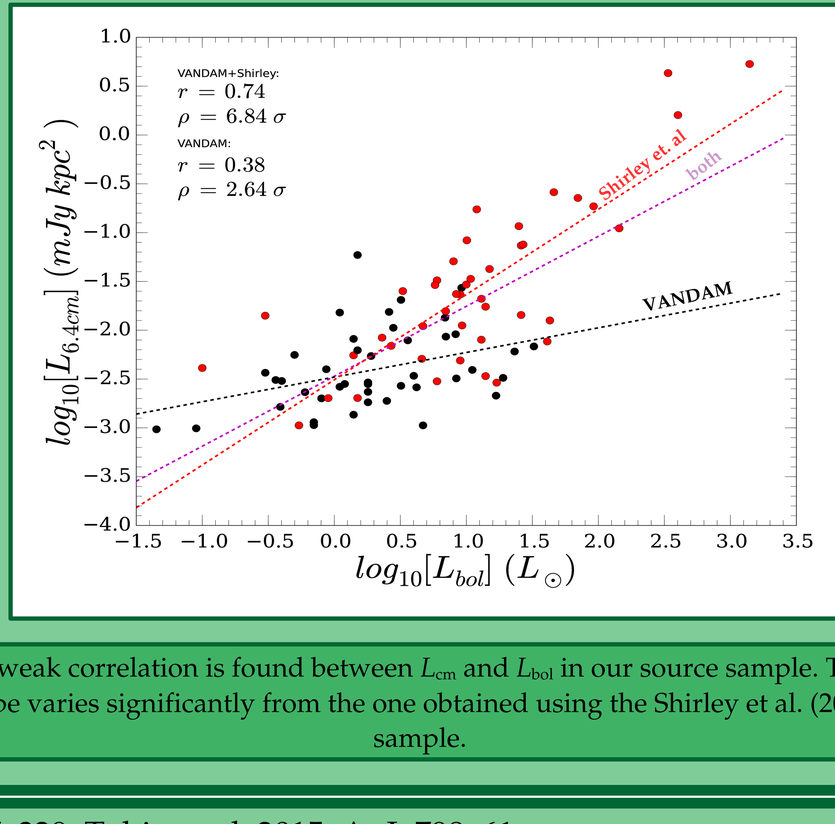


Both sources show decreasing spectral index with the distance from the central protostar. The negative values of those indices are consitent with non-thermal emission.

Conclusions

- Water IR emission and radio emission do not correlate and likely trace different outflow components;
- The correlation exists between [OI] and radio emission suggesting that both trace atomic jet where dissociative shocks are at play;
- Water luminosity increases with disk mass;
- Radio emission of the extended component is consistent with synchrotron emission produced by interaction of outflow shocks and the magnetic field within the outflow;
- Our survey solidifies the L_{cm} and L_{bol} correlation and indicates a need for more observations.

L_{bol} and L_{cm}



A weak correlation is found between L_{cm} and L_{bol} in our source sample. The slope varies significantly from the one obtained using the Shirley et al. (2007) sample.

References: Karska et al. 2013 ,A&A, 552, 141; Karska et al. 2014, A&A, 572, 9; Shirley et al. 2007, ApJ, 667, 329; Tobin et al. 2015, ApJ, 798, 61.

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