A detailed kinematic analysis of the DR21 Main outflow.

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Context: Molecular outflows are commonly detected originating from forming stars. One of the most famous such outflows is that associated with the DR21 Main located in the Cygnus-X molecular cloud. The outflow is believed to arise from a forming massive star and extends close to the plane of the sky. Recent work has suggested the existence of a new type of explosive outflows, formed by the collapse of protostellar clusters. Since then it has been suggested that DR21 Main actually represents an example of this new type of outflows (Zapata et al. 2013).

Aims: Exploring in detail the kinematics and structure of the DR21 Main outflow, using several different molecular tracers, we aim to determine the true nature of the DR21 outflow.

Methods: As part of the with the MPG-IRAM Observatory Programs (MIOP) we have imaged emission from various molecular lines toward the Cygnus-X molecular cloud system, including DR21, with both the IRAM 30m telescope and the NOEMA interferometer. The nature of these observations (low and high angular resolution respectively) allows for the examination of the outflows kinematics and its structure at large and small scales simultaneously.

Results: Integrated intensity maps of HCO^+ emission observed with the IRAM 30m telescope reveals the well known structure of DR21, with a clear bipolar outflow. The clear separation of the two outflow lobes and the simultaneous red- and blue-shifted emission detected in both of them confirm the assumed orientation of the outflow as being close to the plane of the sky. Higher spatial resolution integrated intensity maps constructed using NOEMA observations show no sign of fillamentary outflow structures, a primary characteristic of explosive outflows as described in Zapata et al. (2017). In addition position-velocity maps of HCO^+, HNC, HCN and H_2CO IRAM 30m show a symmetrical velocity distribution for the two outflow lobes, a behaviour more like that of a clear bipolar outflow than the more chaotic nature expected from an explosive outflow. Additionally, signs of a possible interaction between the outflow and a cold, dense structure located west of DR21 Main are found from the integrated intensity maps, but cannot be confirmed from the P-V diagrams.

Conclusions: Overall, the revealed structure of the DR21 Main outflow suggests that it is most likely a typical bipolar outflow, and is therefore not a proper candidate for the newly proposed type of explosive protostellar outflows. Finding signs of interaction of the outflow with the surrounding material, that would allow for a good study of the interface between an outflow and its surrounding material, requires a closer look to be confirmed.

References

[1]Zapata, L. A., “A 10,000 Year Old Explosion in DR21”, The Astrophysical Journal, vol. 765, no. 2, 2013.

[2]Zapata, L. A., “Molecular Outflows: Explosive versus Protostellar”, The Astrophysical Journal, vol. 836, no. 1, 2017.