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标题: High-J CO emission in the Cepheus E protostellar outflow observed with SOFIA/GREAT
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摘要: Context. Owing to the high energy required for their excitation, high-J CO transitions are a valuable tool for the study of protostellar jets and outflows. However, high spectral resolution observations of high-J CO lines, which are essential to distinguish the different components in the line profiles, were impossible until the start of operations of the Herschel Space Observatory and the Stratospheric Observatory For Infrared Astronomy (SOFIA).

Aims. We present and analyze two spectrally resolved high-J CO lines toward a protostellar outflow. We study the physical conditions, as a function of velocity, traced by such high-energy transitions in bipolar outflows.

Methods. We selected the molecular outflow Cep E, driven by an intermediate-mass class 0 protostar. Using the German REceiver for Astronomy at Terahertz frequencies (GREAT) onboard SOFIA, we observed the CO (12-11) and (13-12) transitions (E-u similar to 430 and 500 K, respectively) toward one position in the blue lobe of this outflow, that had been known to display high-velocity molecular emission.

Results. We detect the outflow emission in both transitions, up to extremely high velocities (similar to 100 km s(-1) with respect to the systemic velocity). We divide the line profiles into three velocity ranges that each have interesting spectral features: standard, intermediate, and extremely high-velocity. One distinct bullet is detected in each of the last two. A large velocity gradient analysis for these three velocity ranges provides constraints on the kinetic temperature and volume density of the emitting gas, greater than or similar to 100 K and greater than or similar to 10(4) cm(-3), respectively. These results are in agreement with previous ISO observations and are comparable with results obtained by Herschel for similar objects.

Conclusions. High-J CO lines are a good tracer of molecular bullets in protostellar outflows. Our analysis suggests that different physical conditions are at work in the intermediate velocity range compared with the standard and extremely high-velocity gas.
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