Contribution ID: **12** Type: **Poster**

The meaning of star formation efficiency in accreting clouds: gaseous and stellar mass evolution

The star formation efficiency per free-fall time, defined as e_ff = (SFR/Mg) tff, where SFR is the star formation rate, Mg is the mass of a cloud, and tff is the cloud's free-fall time, is traditionally interpreted as the fraction of a cloud's mass that is converted into stars during the cloud's free-fall time. However, recent observational and numerical results suggest that molecular clouds are continuously replenished by accretion from their environment, causing their masses to increase in time, until they begin to be dispersed by stellar feedback. In this case, clouds can be viewed as funnels rather than as objects with a well defined mass, and the standard interpretation of e_ff becomes blurry. We propose an alternative interpretation of e_ff as the ratio of the observed star formation rate (SFR) to the theoretical free-fall collapse rate of the cloud. This description allows understanding the constancy and low values of e_ff as a consequence of the density and accretion rate radial profiles across the cloud, and of the observational approximations made for estimating the SFR, without resorting to any kind of support. In turn, these radial profiles are time-dependent. We present a toy model that simultaneously follows the gaseous and stellar mass evolution in a cloud, and predicts a lower limit to the time required for the appearance of stars that can disrupt the accretion flow.

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Session Classification: Session 4