1981 to reproduce the original model of Bladford and Rees, indicate a poor degree of collimation. I do not see how with the same mechanism you are able to explain the observed clustering of some HH-objects.

Königl: 1) To the best of my knowledge, none of the currently available observations could be interpreted as implying that the position of a given HH-object coincides with the density peak in the cloud. I believe, in fact, that the data generally are consistent with the HH-objects moving along the direction of the steepest density gradient in their vicinity. 2) You are right that the numerical experiments which you quoted indicate poor collimation. These experiments are admittedly idealized, but in any case one would expect the external pressure distribution and/or the internal magnetic hoop stresses in the jet to provide substantial additional collimation.

Choe: Kelvin-Helmholtz instability may not work at the sides of HH-objects because supersonic regions occur at the sides. When HH-objects are decelerating, then we can also consider the Rayleigh-Taylor instability at the front of HH-objects. Thus, you must take account of decelerating HH-objects.

Königl: With regard to your first comment, the suppression of the Kelvin-Helmholtz instability would presumably depend on how efficiently the shocked jet material is accelerated down-stream from the bow shock. As for the Rayleigh-Taylor instability, I certainly agree that it would be important also for decelerating clumps. In fact, the situation in decelerating clumps is, in this respect, identical to that in accelerating ones.

HYDRODYNAMIC-NUMERICAL MODELS FOR HH-OBJECTS

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We present two-dimensional hydrodynamic calculations based on the interstellar bullet mechanism for Herbig-Haro (HH) object formation. This work is an extension of ideas presented by C. Norman and J. Silk (1979, *Ap. J.*, 228, 197). We present results of high velocity cloudlets (bullets) impacting denser, partially ionized interstellar clouds. The bullets have a velocity of 100 km s^{-1} and may or may not be contained in a lower density 100 km s^{-1} wind. One case of a high-speed wind interacting with a cloud cavity is also discussed. Only the high-speed bullet with wind evolves into a possible HH-object.

DISCUSSION

Ho: 1) What are the physics, e.g., viscocity, self-gravity, etc., used in the calculations? 2) What is the effect of bringing the cloud density up by 1-2 orders of magnitude as may be expected from observations?

Sandford: 1) Equations solved are given in the *Ap. J.*, article cited in our paper. Self-gravity is not included. Viscosity is set to 1×10^{-3} for Kg (see SWK, above), but this is less than the numerical viscosity. Viscous effects are not considered important compared to the numerical diffusion that results from the 1st-order differencing used. The details of radiative cooling are important, however. We solve rate equations giving the balance of collisional ionization and radiative and collisional recombination to an average ground state for H. Recombination radiation is removed from the internal energy but details of line cooling and Lyα scattering are not considered. This scheme approximates the correct physics and it is much better than using a steady-state cooling law which gives a completely isothermal limit and can lead to erroneous densities. It may eventually be necessary to include line cooling details to make quantitative comparisons with data. 2) Bringing the bullet density up by one or two orders of magnitude will result in a case that resembles a shock incident upon a step-down in density and we would expect different phenomenology than presented here. This will be discussed in future work, but it is not easy to anticipate the result.

R. Schwartz: Is the ionized region behind the cloudlet identified with a lee shock as found in your previous work?

Whitaker: No, the lee shock in the previous work was on the opposite side of the cloudlet from the wind.

Sandford: The result calculated here is quite different than the case for a wind incident on a cloudlet. The ionized region behind the bullet results from the interaction of the bullet wake and incident wind flows which concentrate and collisionally ionize gas from the target cloud.