Extrasolar planets around post-common envelope binaries

Christiane Diehl and **Robi Banerjee**

Universität Hamburg
DER FORSCHUNG | DER LEHRE | DER BILDUNG

Hamburger Sternwarte, Gojenbergsweg 112, 21029 Hamburg, Germany
christiane.diehl@hs.uni-hamburg.de

hamburger sternwarte

WHY?

Close stellar binary systems with a post-main sequence component must have gone through the stage of common envelope evolution which also includes stellar mass-ejection. The effect of this stellar evolutionary phase on the dynamics of planets is strong, in most cases leading to the ejection of planets [VBH14], see also poster PF-13. Therefore, the detection of planets in the system **NN Serpentis** [BHD+10] hints to a second stage of planet formation in a circumbinary disk formed after the ejection of the gaseous envelope.

WHAT?

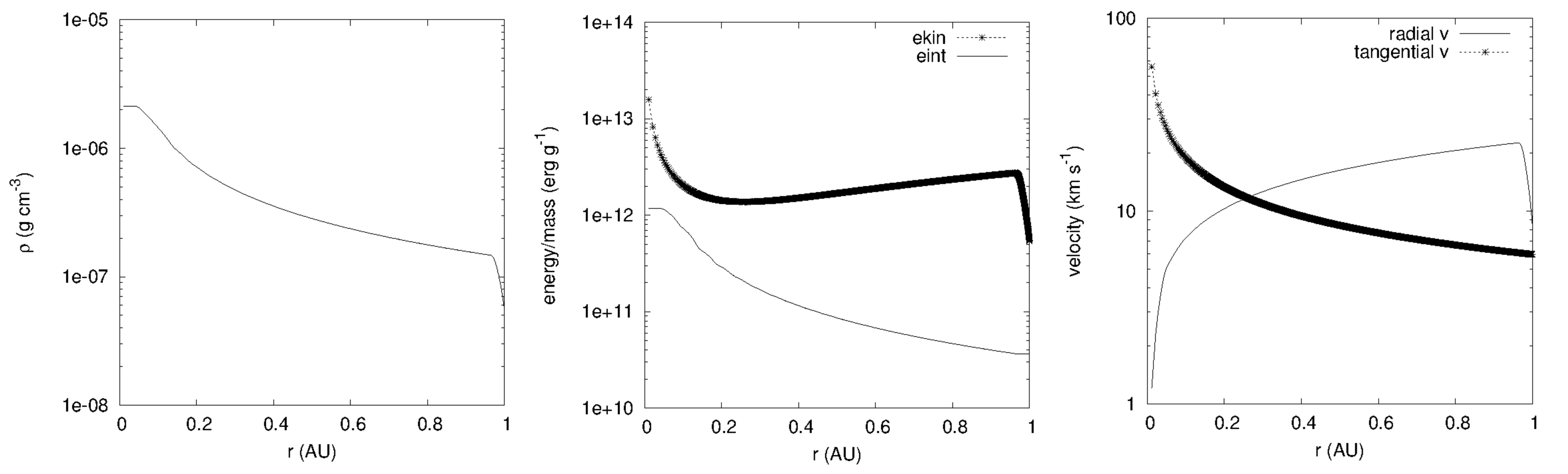
We perform full three-dimensional **hydrodynamical simulations** of planets around close binary stars during the common-envelope phase starting after the rapid-infall phase of the binary. Our goal is to put further constraints on the survival of first-generation planets and discuss the formation of circumstellar disks where second-generation planet formation might occur.

HOW?

The setup for our simulations is a selfgravitating gaseous sphere with defined radial density and pressure profiles. As guideline for the innermost region we use the results of CE simulations by [RT12] and [PDF+12]. The envelope expands with a radial velocity increasing with radius and rotates around the z-axis of our simulation box. The stellar binary is represented by a sink particle that only interacts gravitationally. Sink particles are also used for the representation of planets. This initial setup is evolved in time making use of the hydrodynamics unit within the **FLASH** code [FOR+00].

Figure 1: (right side) Initial radial profiles for (a) density, (b) kinetic and thermal specific energy and (c) radial and tangential velocity.

This is a zoom-in on the central region of the box with length $4{\cdot}10^{14}$cm.



WHAT IT LOOKS LIKE

Initial parameters for this simulation:

Envelope mass M_{env}	$1.5M_{\odot}$	Binary mass M_s	$0.65M_{\odot}$
Envelope radius R_{env}	1AU	Binary position (in AU)	0, 0, 0
Core radius R_{core}	0.067AU	Planet 1 mass M_{p1}	$6.32M_J$
Density power-law index α	-1.0	Planet 1 position	-2.0, 0, 0
Kinetic energy $E_{kin,tot}$	$6.08{\cdot}10^{45}$erg	Planet 2 mass M_{p2}	$2.1M_J$
Thermal energy $E_{th,tot}$	$2.66{\cdot}10^{44}$erg	Planet 2 position	3.5, 0, 0

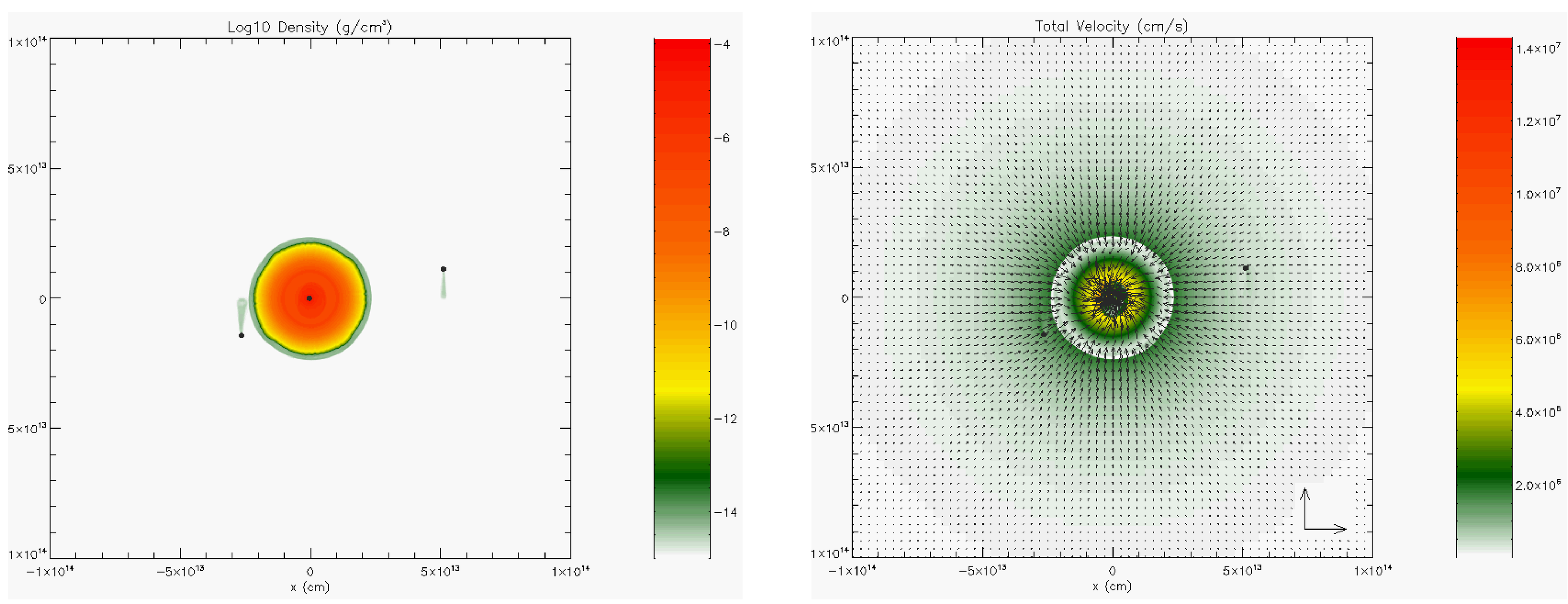


Figure 2: Left to right shows (a) density in the x,y-plane, (b) total velocity overplotted with velocity vectors scaled to 5km/s. Both images show the evolution after 0.15 years.

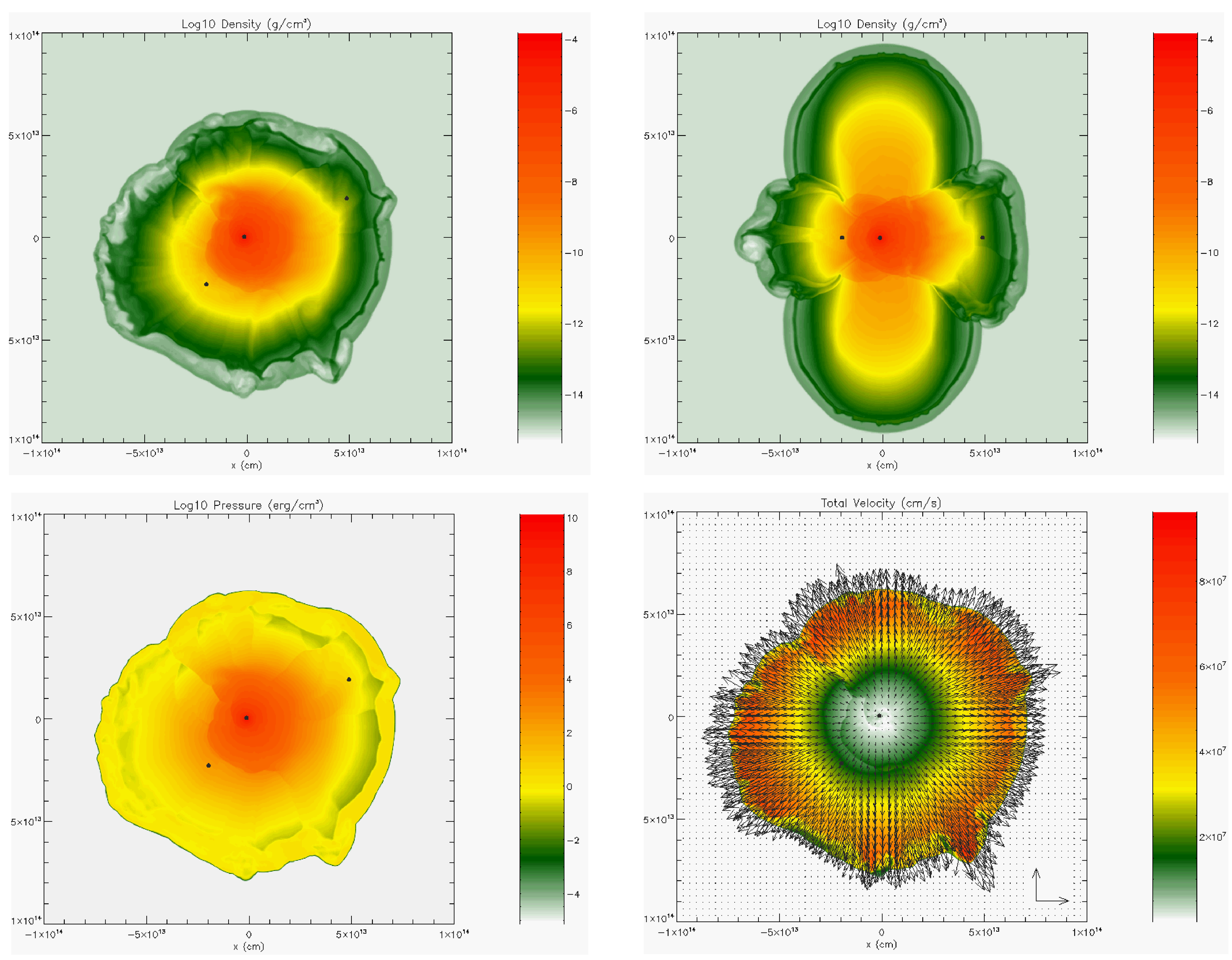


Figure 3: Top left to bottom right shows (a) density in the x,y-plane, (b) density in the x,z-plane, (c) pressure in the x,y-plane and (d) total velocity overplotted with velocity vectors scaled to 60km/s in the x,y-plane. All images show the evolution after 0.27 years.

THE FUTURE

The observational study of CE events is very difficult since this is only a short phase during stellar evolution. Therefore, we mainly rely on 3D simulations. However, current simulations can not fully reproduce the outcome of a CE event and of course depend on the initial conditions and approximations.

This is why we plan to run multiple simulations **exploring the parameter space** for the following parameters:

- Kinetic energy
- Thermal energy
- Density power-law index
- Number of planets
- Planetary masses and positons

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