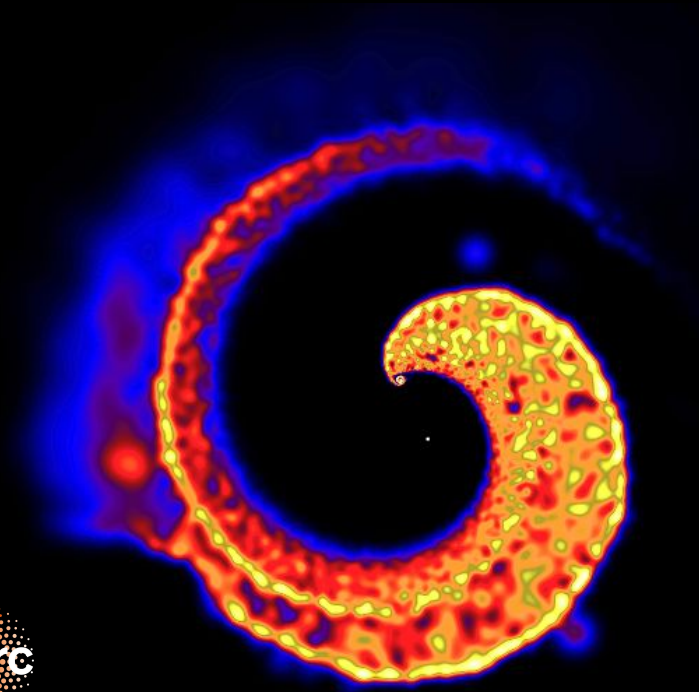
Companion-induced dust formation in AGB winds

Davide Dionese

Supervisors: Lionel Siess (ULB)
Dorota Skowron (UW)

AGB stars and stellar pulsation,
Konkoly Observatory - 6 October 2026



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3D Hydrodynamical wind simulations with PHANTOM

Phantom: 3D Smoothed Particle Hydrodynamics (SPH) code



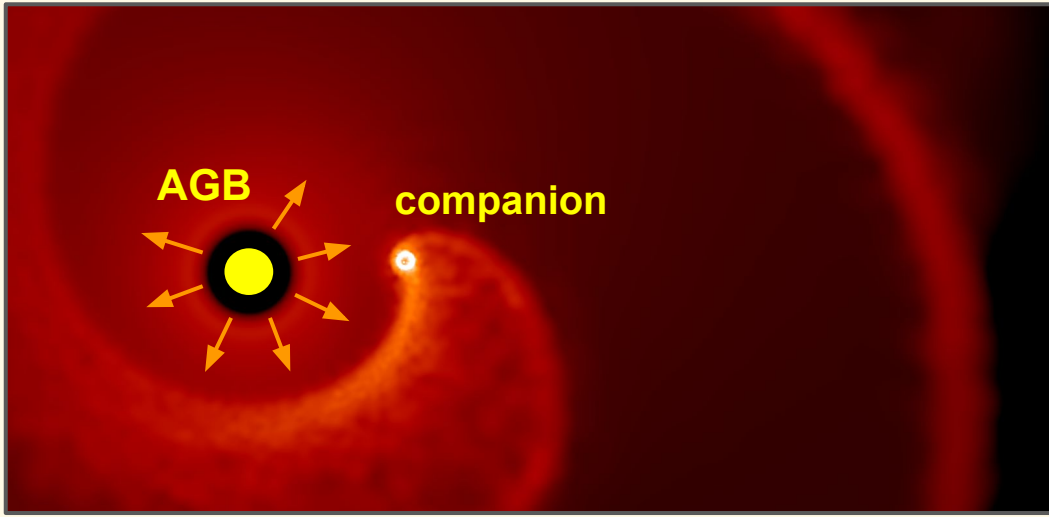
AGB
"Free winds"
C-rich

✚

Companion
(Sub)stellar mass
Point mass

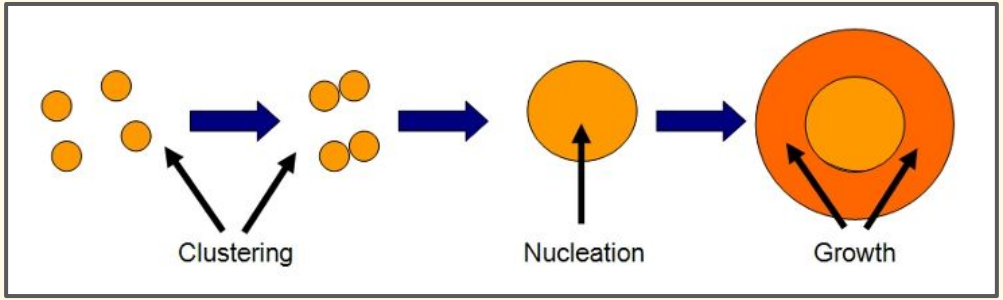
Main goals:

- Model wind-companion interaction
- Follow accretion on the companion
- Investigate dust formation
- Assess companion's impact on AGB outflows at large scales



Dust formation

2-step process



1. Nucleus formation

- Process operates on a molecular scale
- Seeds contain 100 to 1000 atoms
- Nucleation rate computed from abundance of monomers (dust building blocks)

2. Grain growth

- Gas molecules stick to grain surface and make it grow
- Growth proceeds via:

$$C_N + C \longrightarrow C_{N+1}$$
$$C_N + C_2 \longrightarrow C_{N+2}$$
$$C_N + C_2H_2 \longrightarrow C_{N+2} + H_2$$
$$C_N + C_2H \longrightarrow C_{N+2} + H$$

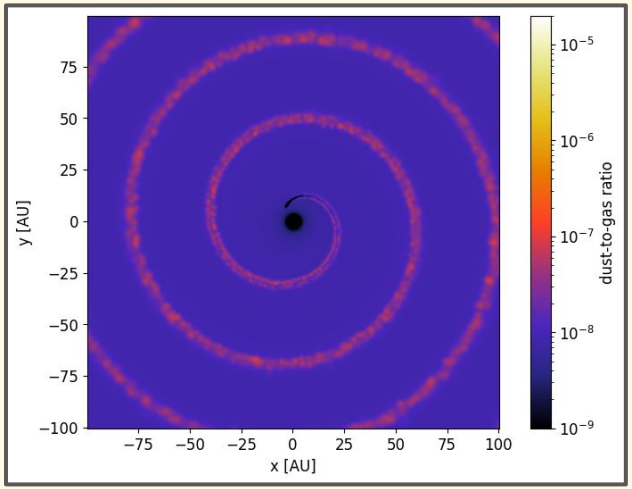
A grid of models

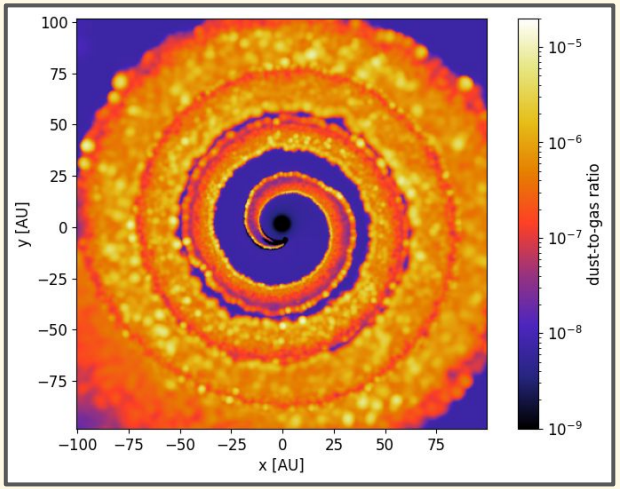
Varying:

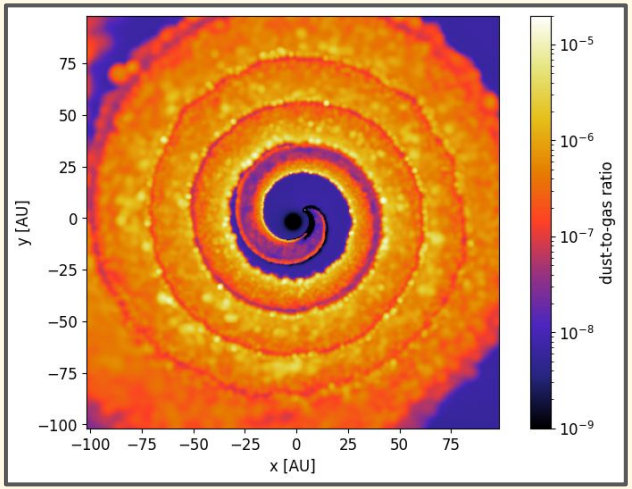
- Mass loss rate
- Separation
- Companion mass

How do they affect dust formation?

M2 [Msun] = 0.1 0.6 1

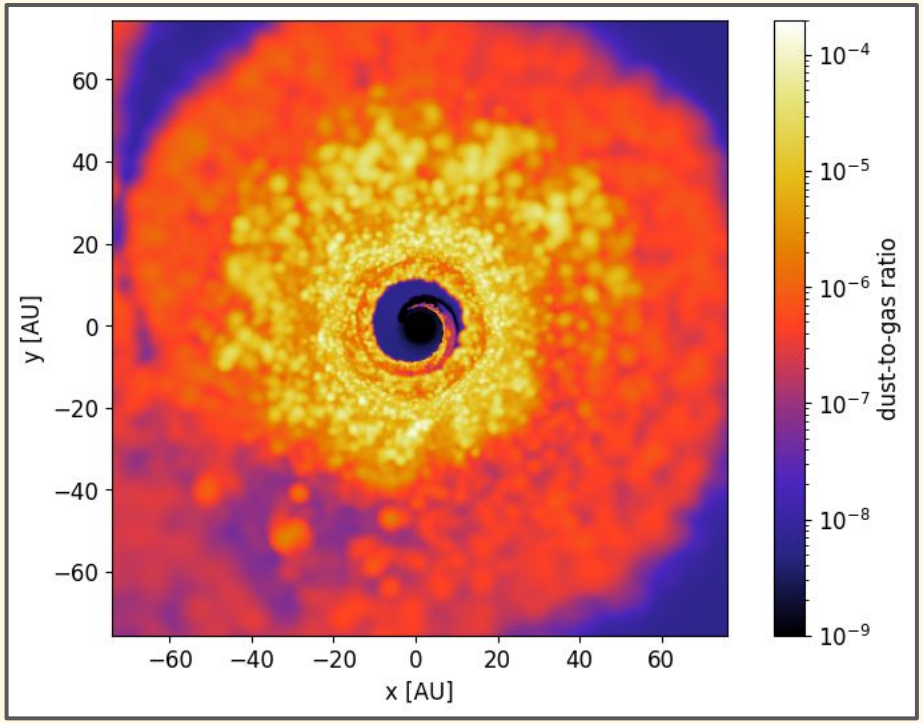


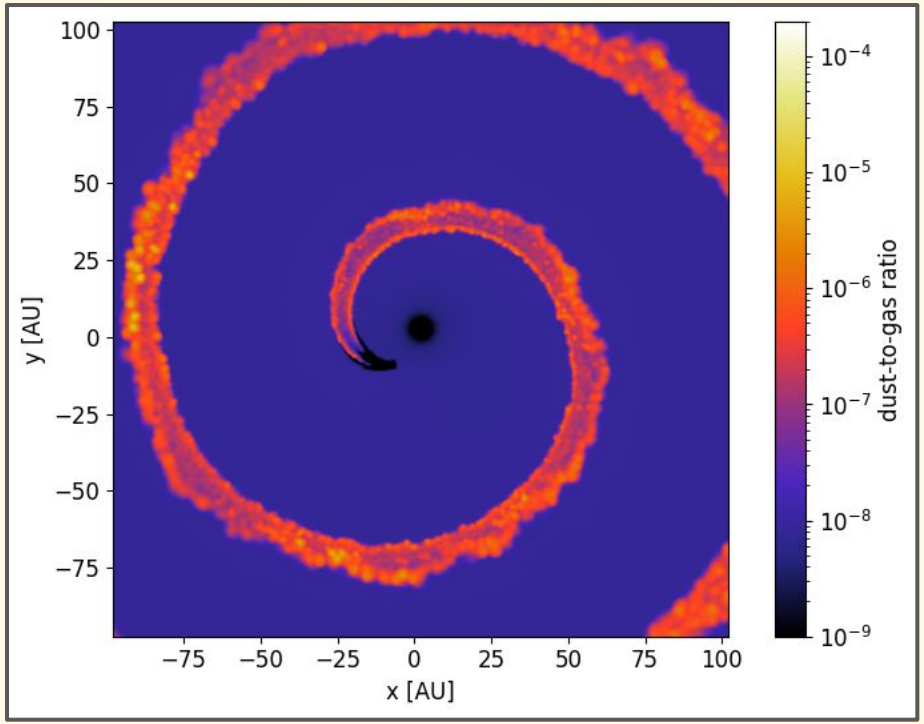




Ṁ	1e-6 Msun/yr
Separation	8 AU

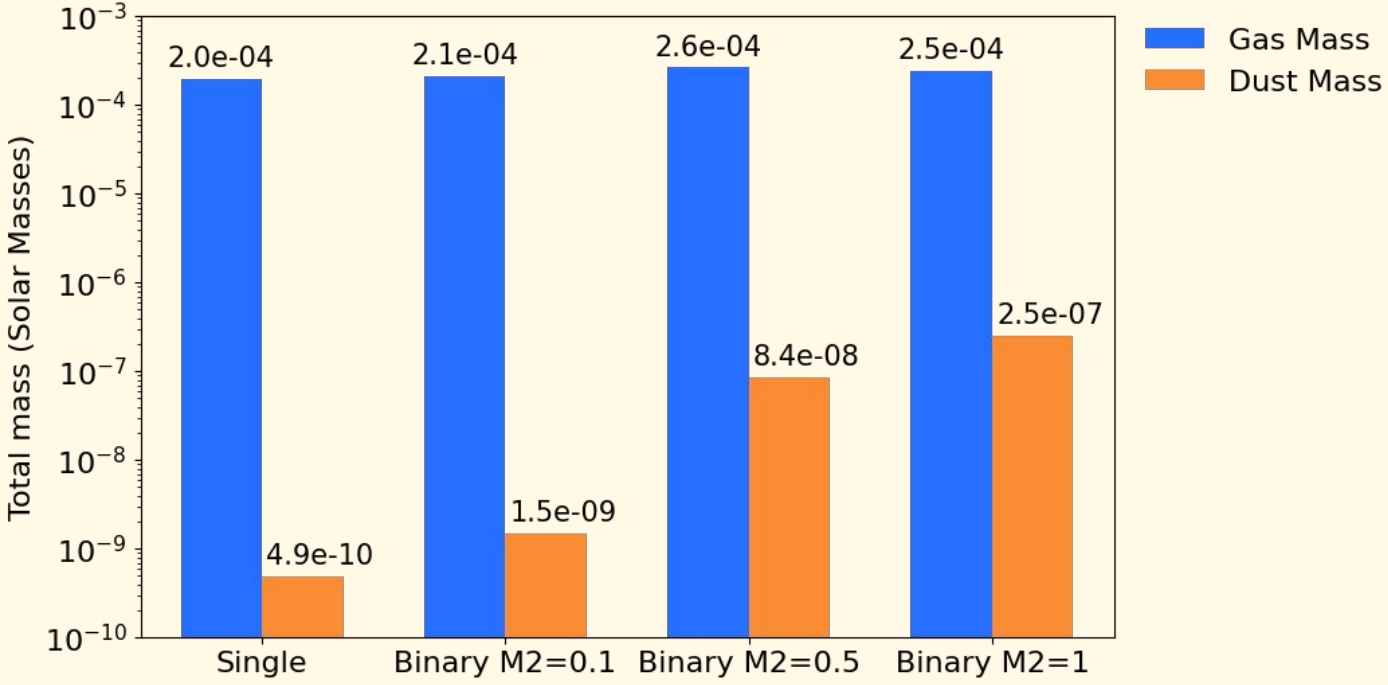
Separation [AU] = 5 15





$\dot{M}$	1e-6 M_{sun}/yr
M2	0.6 M_{sun}

Total dust production



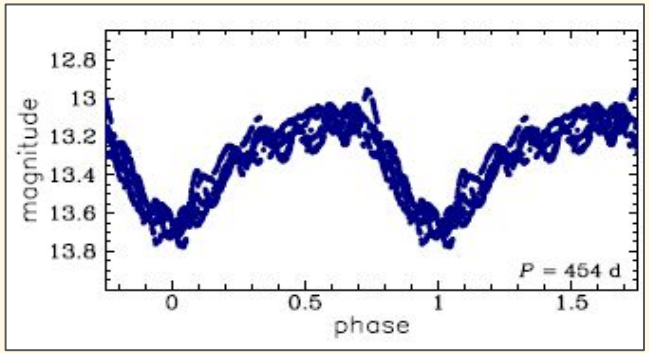
$\dot{M}$	1e-5 M_{sun}/yr
M1	1.5 M_{sun}

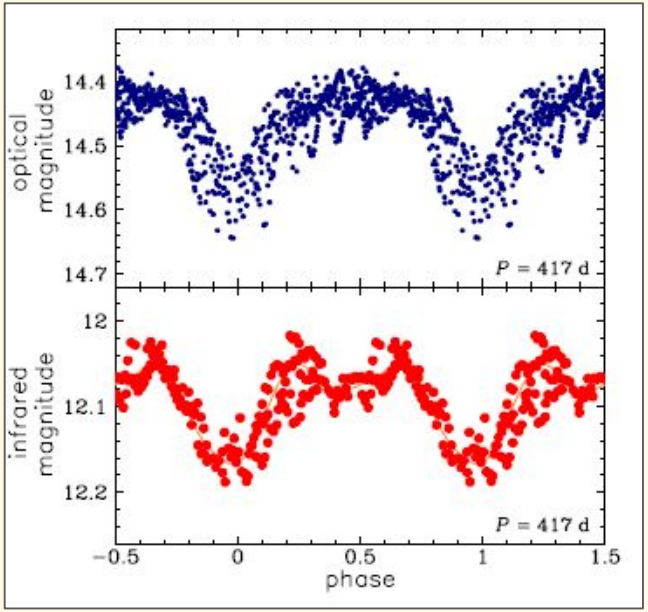
Because LSPs are trendy

Eppur binaria non è esclusa:



Credits:
Matylda
Soszynska



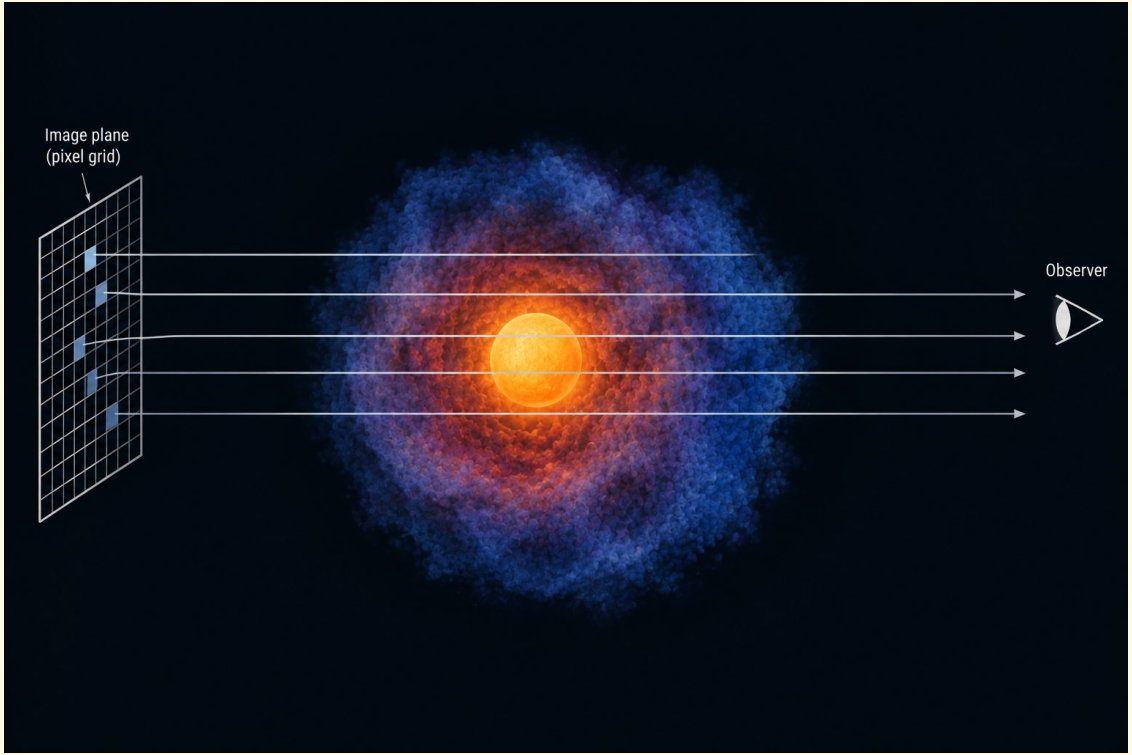


Synthetic images

Radiative transfer with Splash

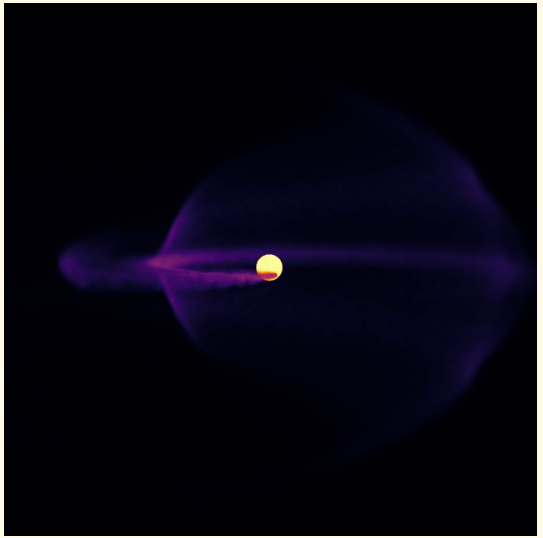
absorption emission

$$I_{\nu,i+1} = I_{\nu,i}e^{-\tau_i} + S_{\nu,i}(1 - e^{-\tau_i})$$

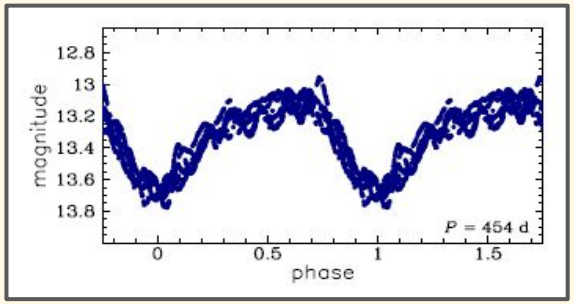


Key assumptions:

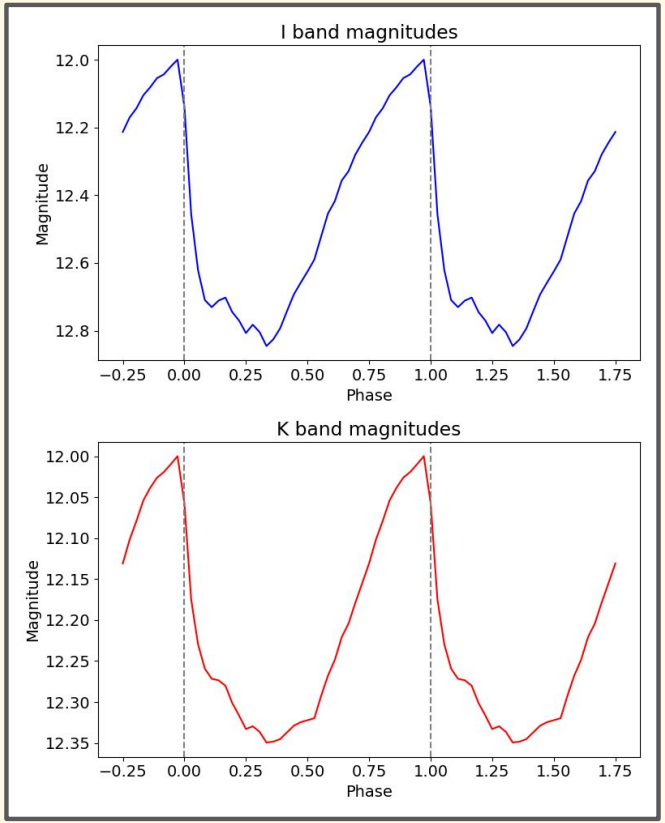
- Tdust = Tgas
- Black body emission



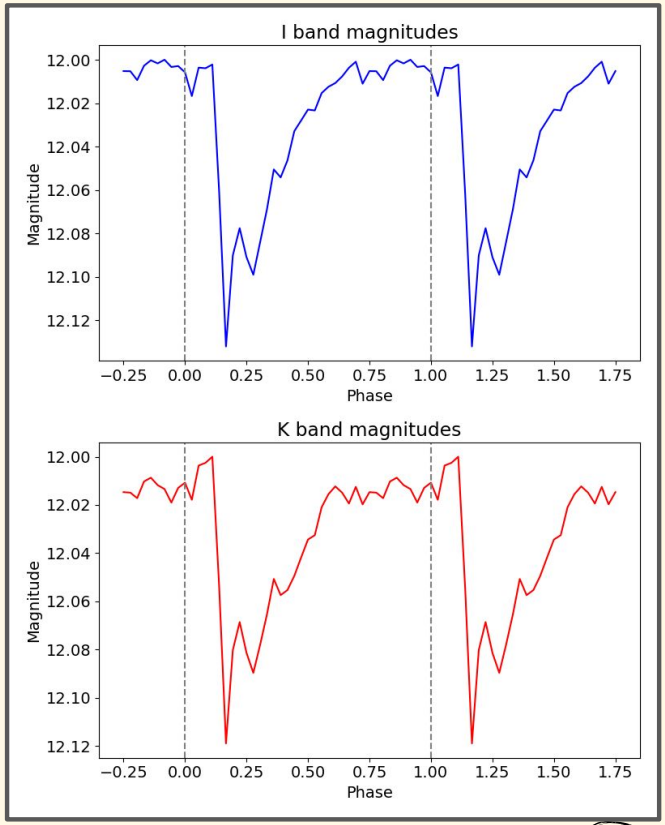
Light curves

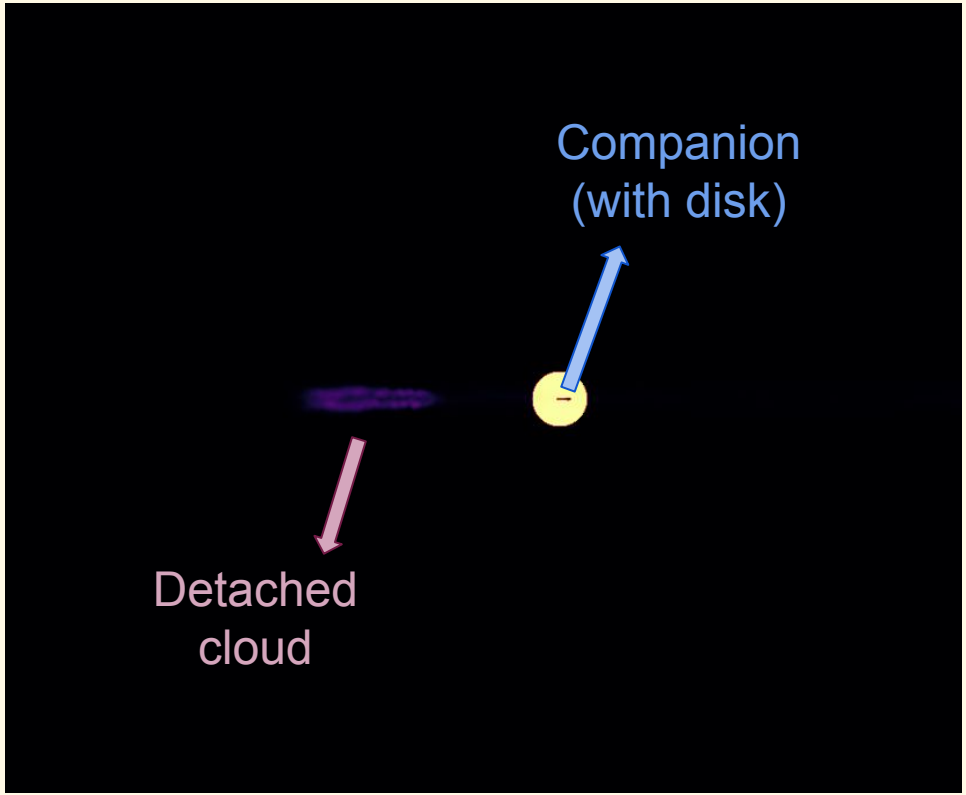


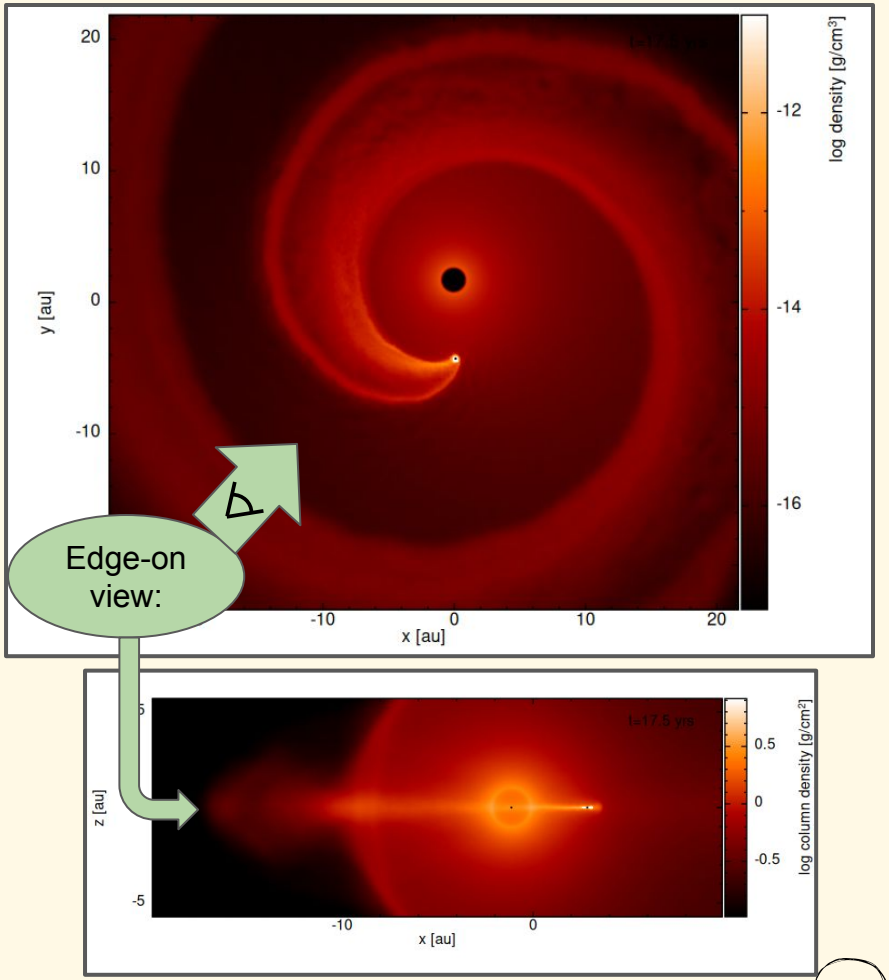
Ṁ = 1e-5



Ṁ = 3e-6




Companion
(with disk)
Detached
cloud


20
10
0
-10
y [au]
-10
0
10
20
x [au]
-12
-14
-16
log density [g/cm³]
b
Edge-on
view:
t=17.5 yrs
z [au]
-5
-10
0
x [au]
0.5
0
-0.5
log column density [g/cm²]

Summary

- **3D Phantom hydrodynamic simulations** including **dust formation**
- The **presence of a companion** strongly alters the **amount and spatial distribution of dust**, producing denser, asymmetric wakes.

- Primitive **radiative transfer** calculations on binary hydrodynamical models
- Successfully reproducing some **LSP light curves** features