# Gas dynamic simulations of inner regions of protoplanetary disks in young binary stars

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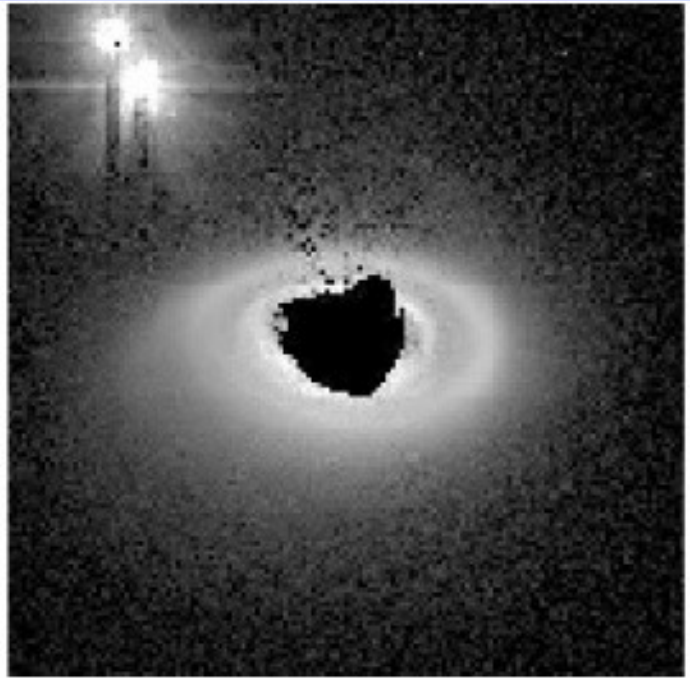
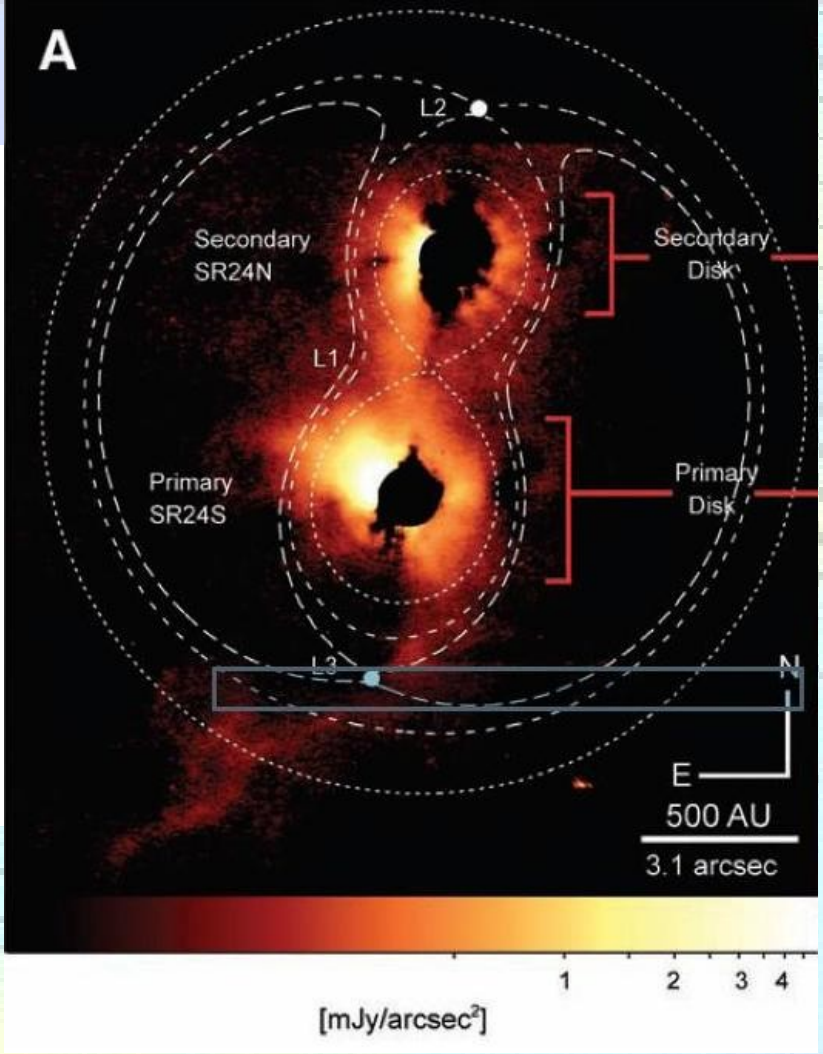
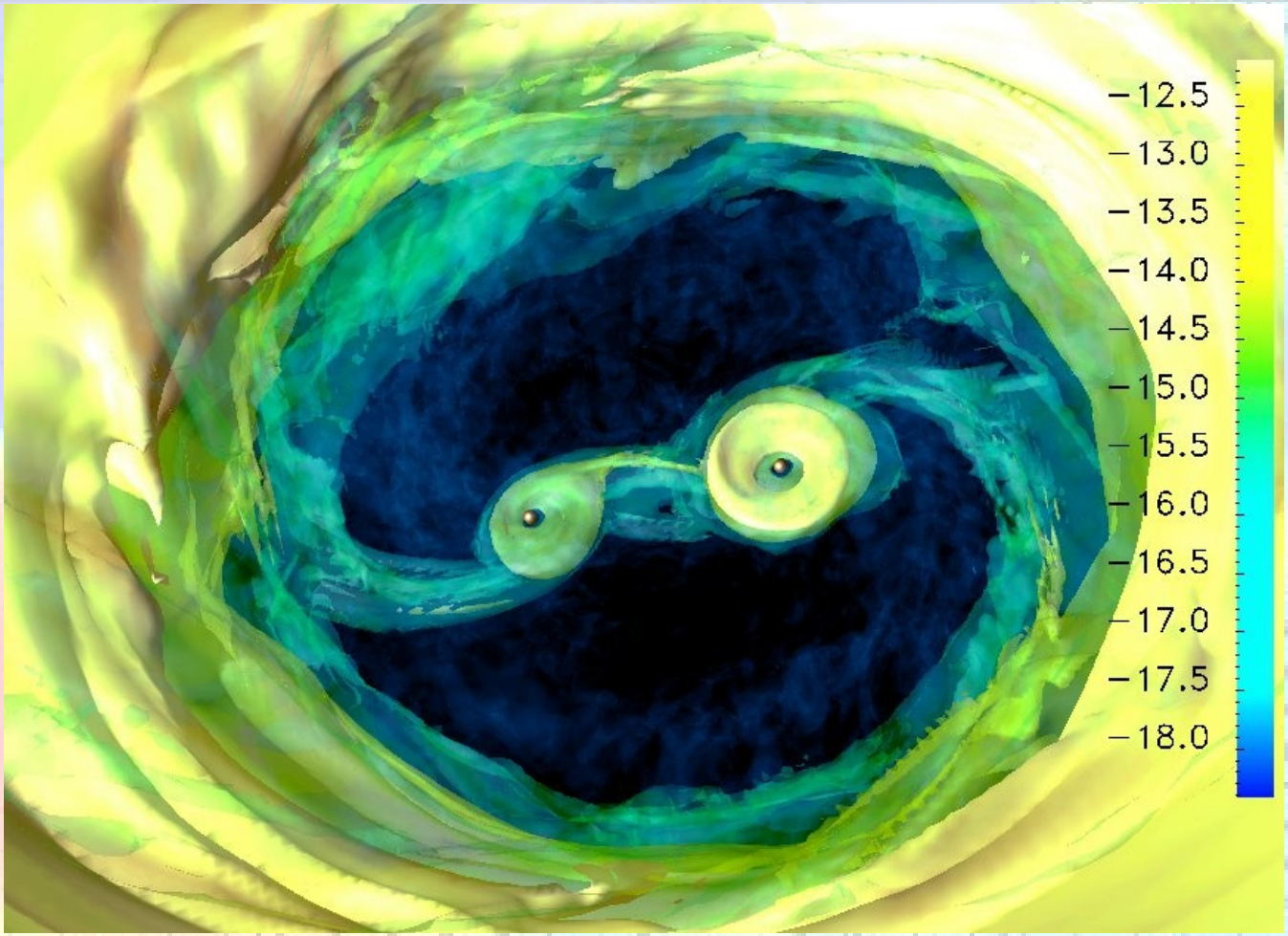


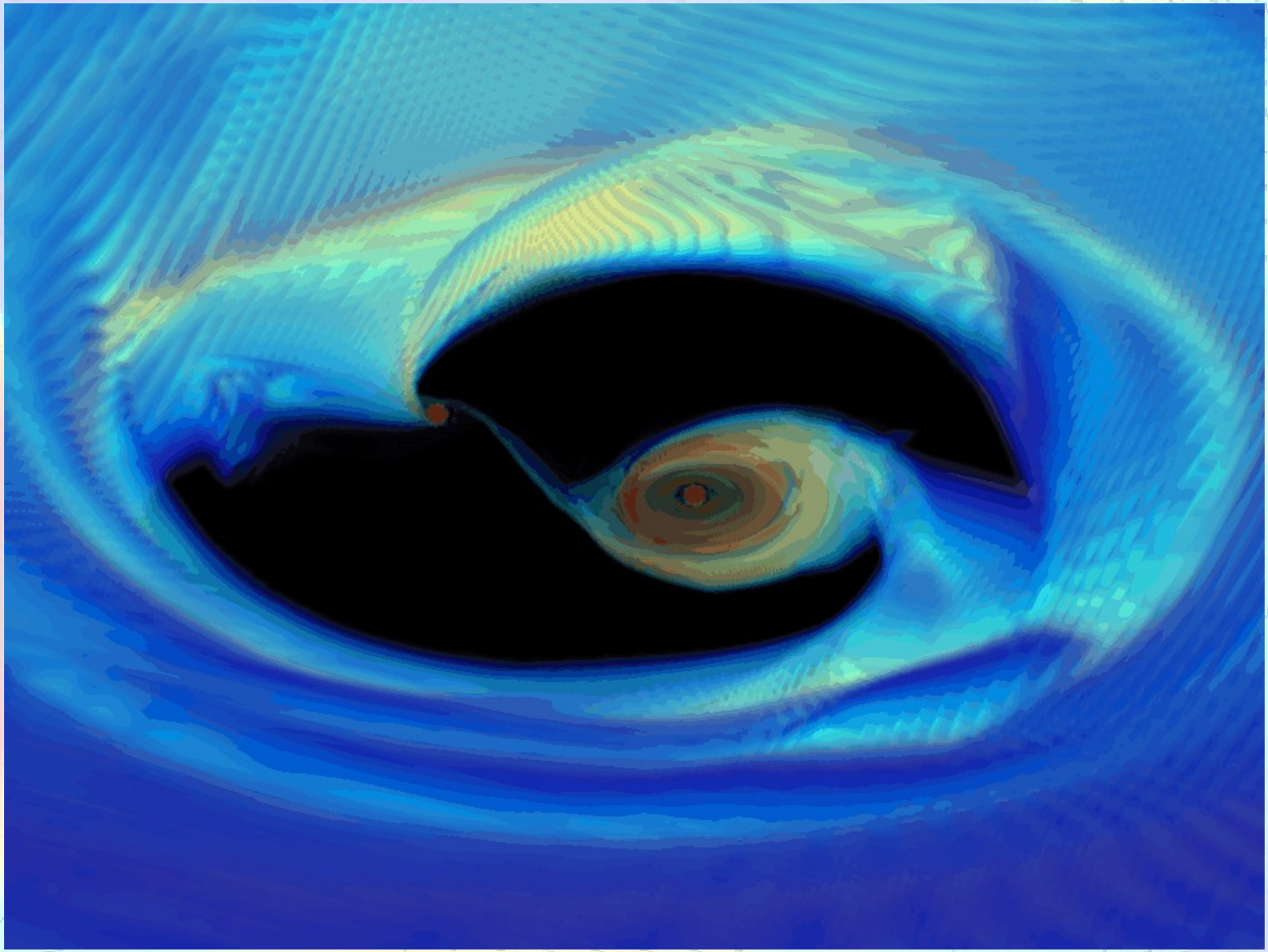



**We consider binary TTs with low-mass disks and low accretion rates, to be able to neglect self-gravitation and assume that the velocity distribution in the outer parts of the disks is close to Keplerian.**

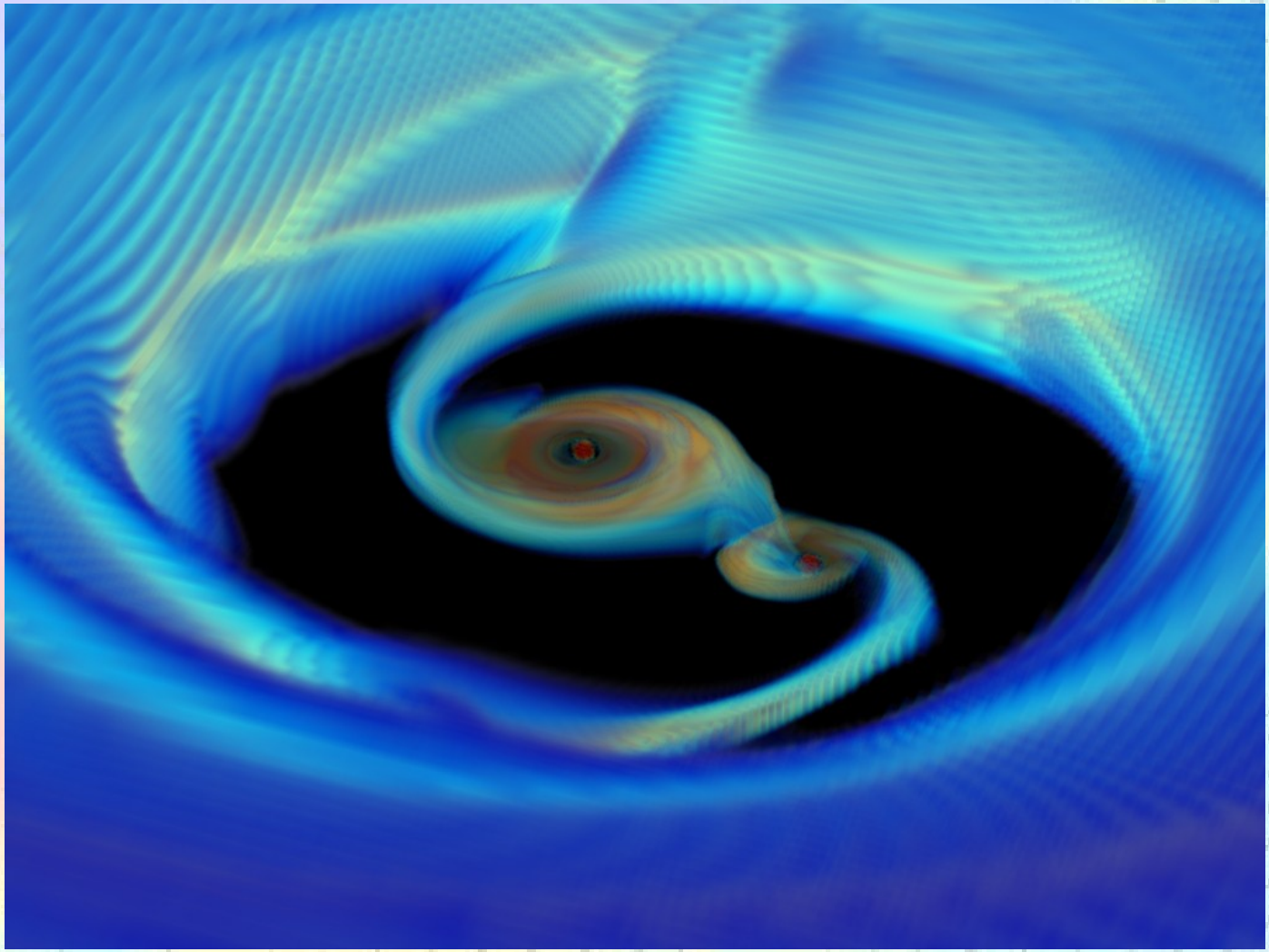
| Star | *A*[AU] | *P*[d] | *q* | *e* |
|---|---|---|---|---|
| **V4046 Sgr** | 0.04 | 2.42 | 0.8 | 0.01 |
| **GW Ori** | 1.13 | 241.9 | 0.32 | 0.04 |
| **DQ Tau** | 0.135 | 15.8 | 1 | 0.56 |
| **UZ Tau E** | 0.153 | 19.13 | 0.3 | 0.33 |
| **Roxs 42C** | 0.3 | 39.15 | 0.91 | 0.48 |




**Analysis of the density and velocity distributions shows that the flow structure is rather complicated and includes a number of details. The solution clearly demonstrates presence of circum-stellar disks surrounding the components, bow-shocks and a “bridge” connecting the circum-stellar accretion disks.**

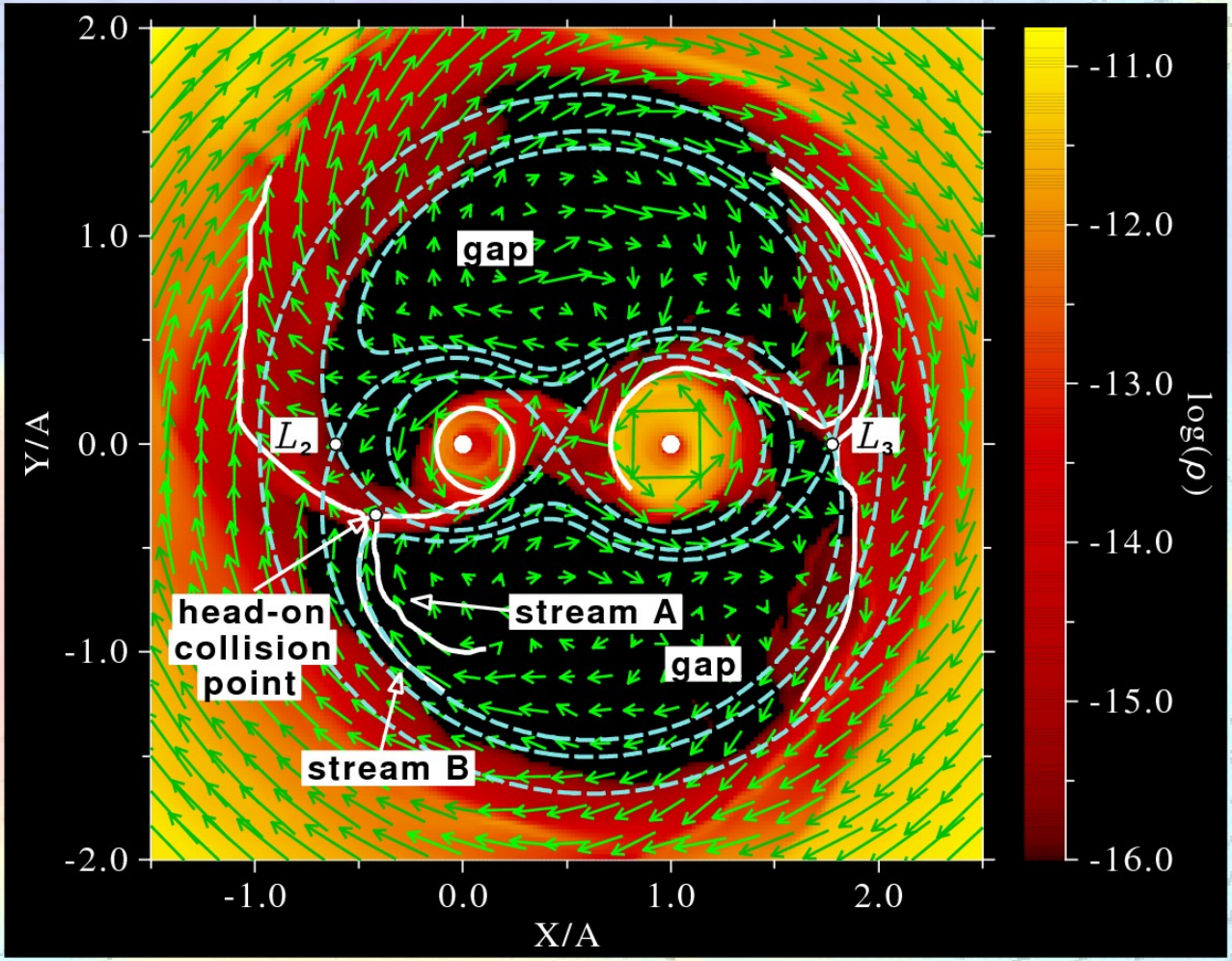


Gas velocities in the rarefied region near the binary are significantly non-Keplerian. This means that the flow pattern in this region is mainly governed by gas dynamic processes.

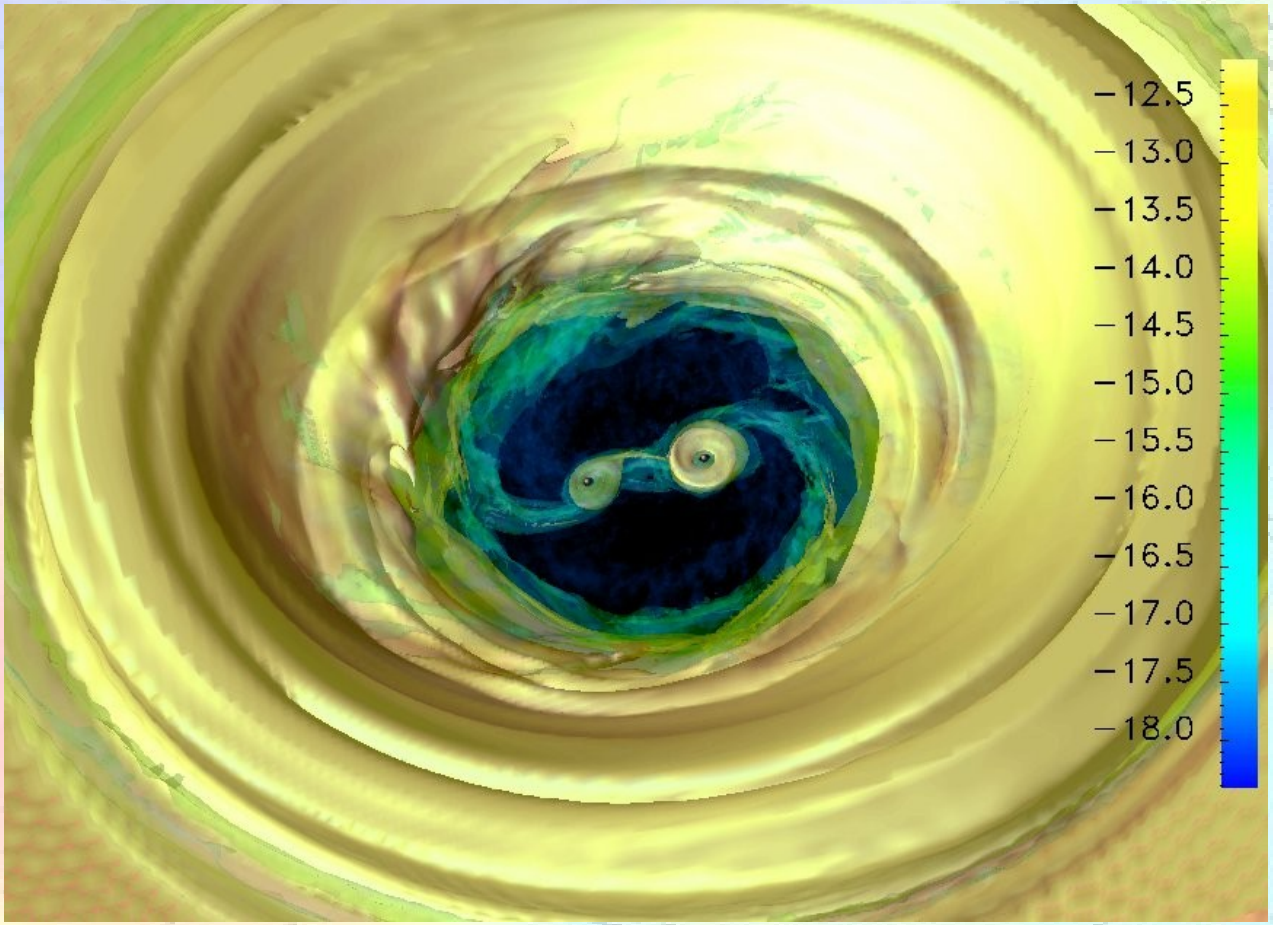


**Results of 2D and 3D simulations proved the conclusion that the bow-shocks occurring due to supersonic motion of the components in the gas of the disk drastically change the flow pattern. In particular, they govern the size and shape of the gap.**

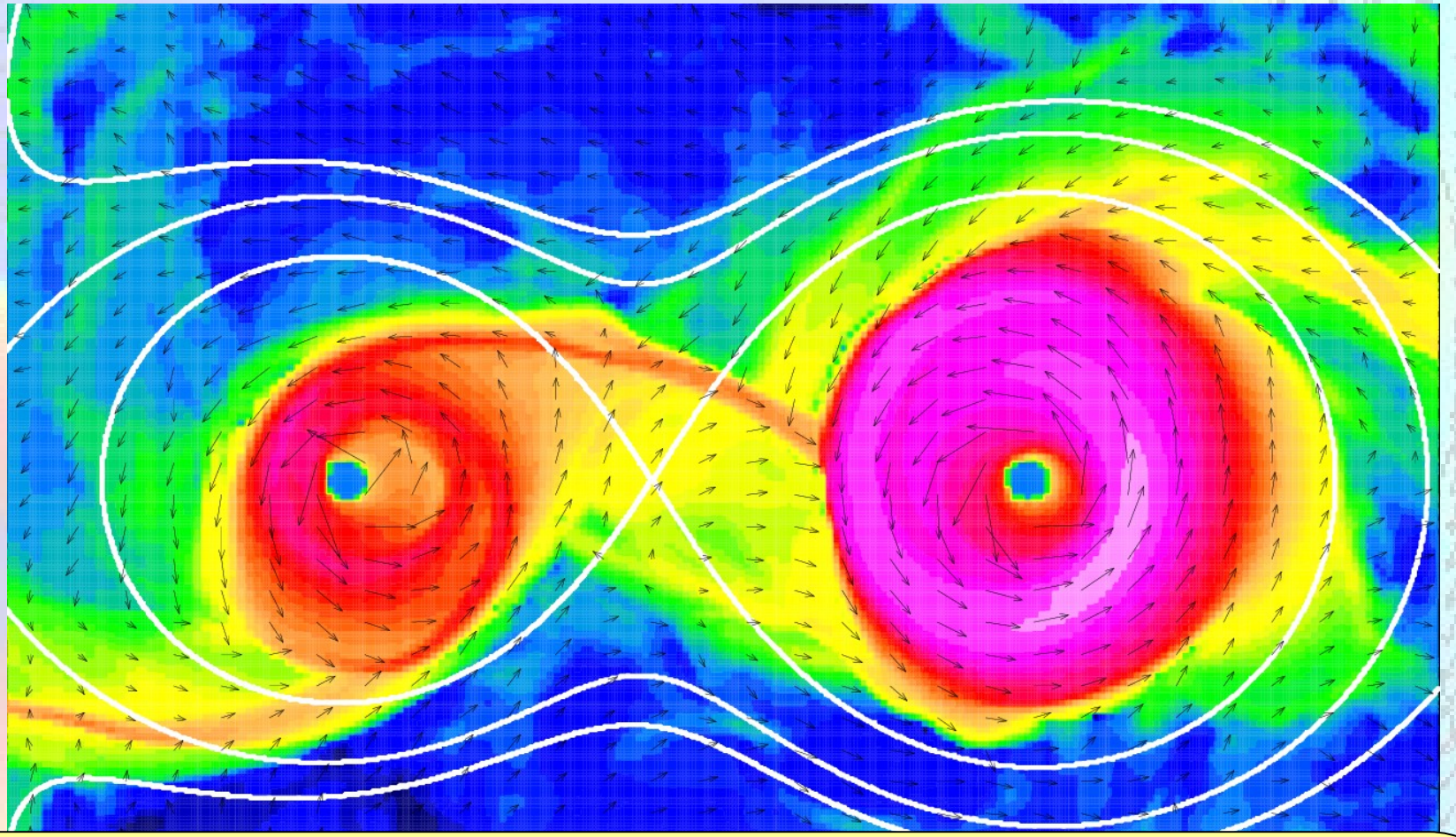
| Star | $R_{res}$ (a.u.) | $R_{shock}$ (a.u.) | $R_{obs}$ (a.u.) | $e$ |
|---|---|---|---|---|
| **V4046 Sgr** | 0.072 | 0.118 | 0.18 | 0.01 |
| **GW Ori** | 2.0 | 3.4 | 3.3 | 0.04 |
| **DQ Tau** | 0.4 | 0.45 | 0.5 | 0.56 |
| **UZ Tau E** | 0.4 | 0.51 | 0.7 | 0.33 |
| **Roxs 42C** | 0.75 | 0.9 | 0.85 | 0.48 |




**Analysis of the fluxes demonstrates that the re-distribution of the angular momentum in the envelope due to the bow-shocks leads to occurrence of two well seen flows propagating from the inner edge of the circum-binary disk to the components.**




**The secondary-less massive star moves faster than the primary. It means that the gas loses more angular momentum at the secondary's stronger shock. Besides, the secondary is located closer to the edge of the circum-binary disk where the gas density is higher. The flux of matter from the inner edge of the protoplanetary disk toward the less massive component is larger.**



**The circumstellar accretion disk cannot accept all the falling matter. This leads to the complex redistribution of matter in the region between the circumstellar accretion disks. As a consequence, despite the higher matter flux from the protoplanetary disk toward the secondary, the most of matter is accreted onto the primary component.**

# Conclusions

- *It is shown that two bow-shocks caused by supersonic motion of the binary components in the gas of the disk are formed in the system having parameters typical for T Tauri stars.*
- *These bow-shocks significantly change the flow pattern. In particular, they determine the size and shape of the inner gap. For the systems with circular motions of the components the gap radius is ~3A and for the systems with elliptic orbits it is ~3.2-3.3A.*
- *Two spiral flows of the matter from the inner edge of the circum-binary disk to the system components are caused by the presence of the bow-shocks.*
- *The flux of the matter from the inner edge of the circum-binary disk toward the less massive component is larger.*
- *The circum-stellar accretion disk can not accept all the falling matter. The flows of the exceeding matter round the disks and collide with each other in the region between the disks. As a consequence the most of matter accretes onto the more massive component.*