Hydrodynamical simulations of G2 interpreted as a diffuse gas cloud

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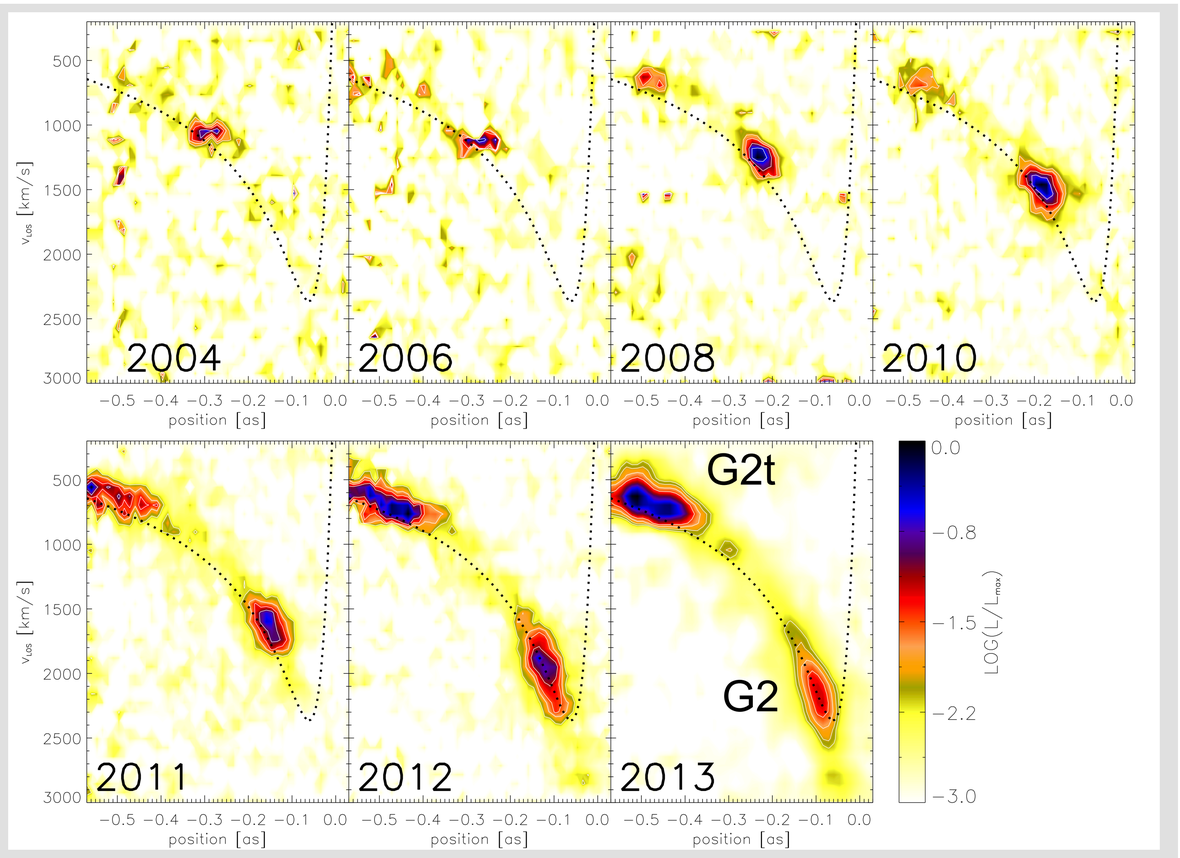
Observational Properties

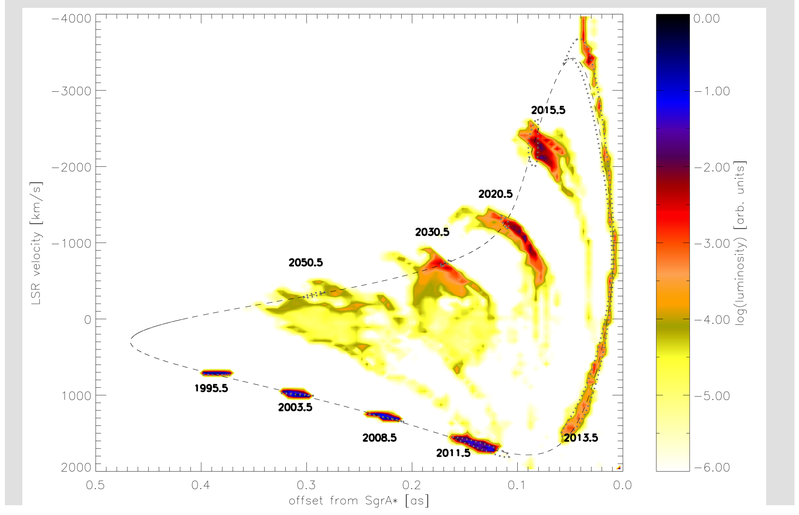
Recently, Gillessen et al. (2012) discovered a fast moving object within the range of the S-stars close to Sgr A*. VLT NACO images show the object in L-band, but not in K-band, indicating that it is a dusty gas cloud. The astrometric data accurately constrains the orbit to be highly eccentric (e=0.98) with a peri-centre passage at a distance of only 2400 Schwarzschild radii, which is currently ongoing. The cloud has a mass of roughly 3 earth masses and an orbital period of roughly 400 years. The tidal interaction with the central massive black hole is clearly visible in the position-velocity diagrams shown here. In the 2013 observations a fraction of the cloud has already passed peri-centre and shows up in the blue-shifted part of the PV diagram.

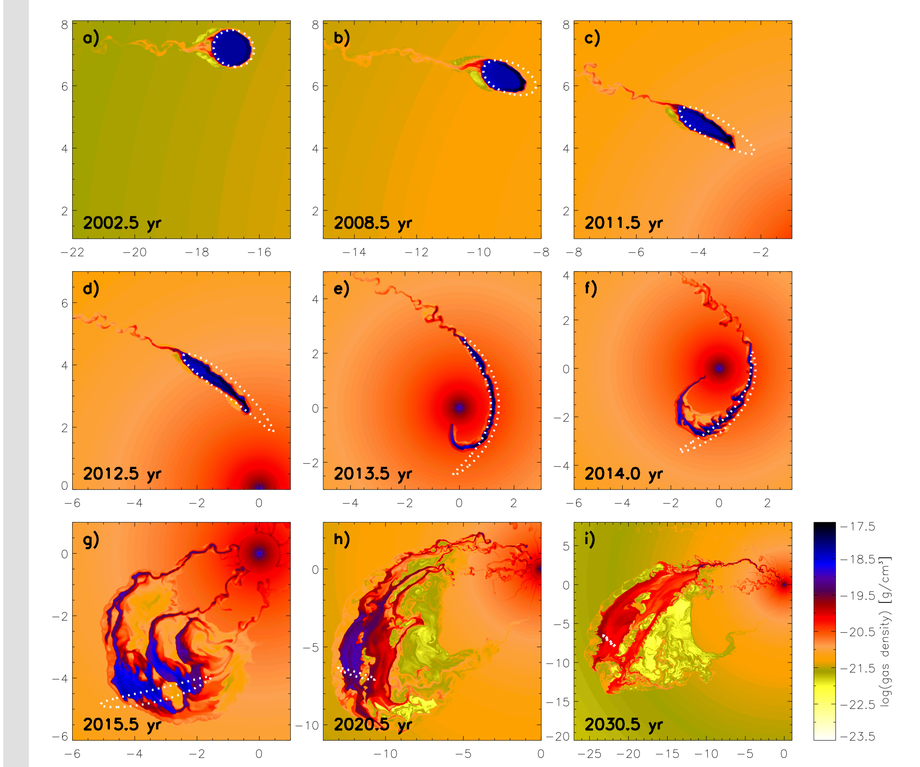


Gillessen et al., 2012, 2013a,b

The Compact Cloud Scenario

With the help of hydrodynamical simulations with PLUTO (Mignone+ 2007) in 2D and 3D AMR we investigate G2 ‘s origin and fate. For the Compact Cloud Scenario, we assume that the cloud started in pressure equilibrium at the 1995.5 position of the observed orbit in spherical shape. The cloud stretches due to tidal forces of the central massive black hole, which also accelerates the destruction of the cloud due to the interaction with the hot ambient atmosphere by its ram pressure and Kelvin-Helmholtz instabilities. The atmosphere is treated with an idealised model based on ADAF solutions by Yuan et al. 2003. After pericentre passage, the cloud gets disrupted and feeds gas onto Sgr A* in a clumpy stream of gas. Good agreement is found between the simulations and the observed position-velocity diagrams, showing dramatic changes in 2013.

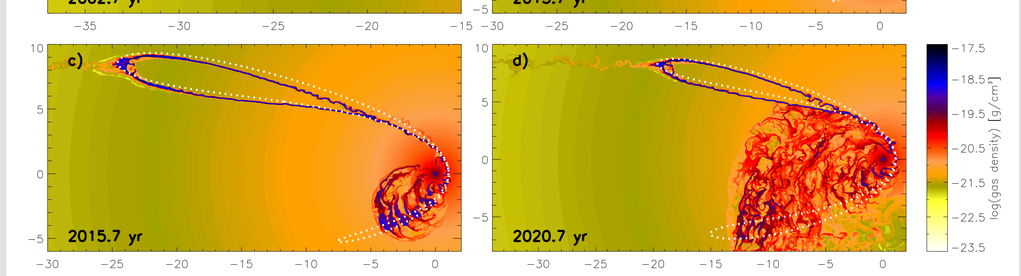


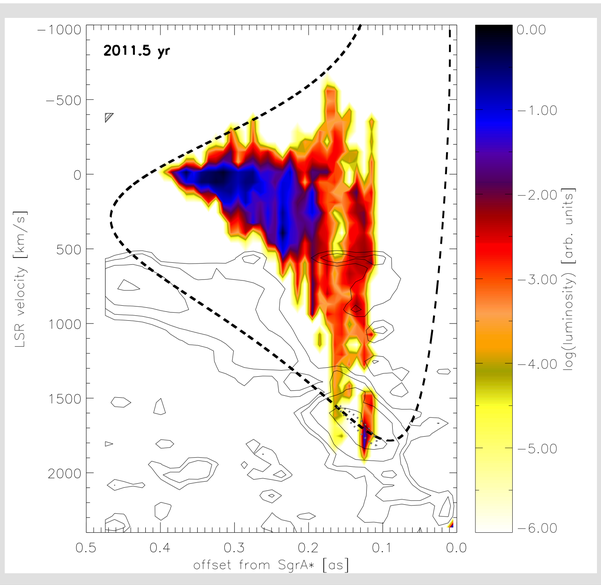


Schartmann et al., 2012; Burkert et al., 2012

The Problem of the Tail

So far, only the main component G2 has been investigated. It is, however, followed by a trailing component of similar mass. As shown in the PV diagram below, the latter cannot be explained by gas stripped from a cloud caused by hydrodynamical interactions.





The upper right plot shows the possibility of a spherical shell on a slightly different orbit, capable of explaining both components, G2 and G2t, as visible in the PV diagram on the lower right plot (panel 3 and 4). Alternatively, both components could be part of a clumpy stream of gas pointing towards Sgr A*.