Wolf-Rayet Stars
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Formation of the infalling Galactic Centre cloud G2 by collision of stellar winds

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The gas cloud G2 is currently being tidally disrupted by the Galactic Centre super-massive black hole, Sgr A*. The region around the black hole is populated by ~ 30 Wolf-Rayet stars, which produce strong outflows. Here we explore the possibility that gas clumps like G2 originate from the collision of stellar winds via the *non-linear thin shell instability*.

Gillessen et al. (2012) detected a moving diffuse object, the so-called G2 cloud, on its way toward the central super-massive black hole of our Galaxy. The object might be a gas clump created by the collision of stellar winds from the young stars in the Galactic Centre (Burkert et al. 2012; Schartmann et al. 2012). Although cold dense clumps are produced in SPH simulations performed by Cuadra et al. (2008), it is not clear whether their formation is physical or dominated by numerical artefacts (Hobbs et al. 2013). This work aims to test independently clump formation as the result of colliding stellar winds in the central parsec of the Milky Way. For more details see Calderón et al. (2015).

Colliding wind systems generate dense slabs of shocked gas located between the stars. This slab can become unstable easily if the shocked gas cools down rapidly. In this case, the dominant instability in the slab is the *non-linear thin shell instability* (Lamberts et al. 2011) which was described by Vishniac (1994). The instability results from the misalignment of the thermal pressure within the cold slab (perpendicular to the slab) and the ram pressure of the wind (parallel to the wind direction). Tracking the thermal evolution of the slab after the winds collide, we estimated the time evolution of the unstable wavelength criteria.

Here we present models of identical wind collisions using as input parameters the stellar separation and wind terminal velocity. The mass loss rate was fixed to 10^{-5} $M_\odot$ yr^{-1} as typically observed in Wolf-Rayet stars in the central star cluster. Once we estimated the unstable wavelength range, we computed the mass of the possible clumps assuming spherical symmetry. Our results are shown in Figure 1: clumps with masses of the order of Earth's, i.e., similar to that observed for G2 (Gillessen et al. 2012), are possible, but require short stellar separations and slow winds.

Following the orbits of the known mass-losing star sample within the inner parsec of the Milky Way (Paumard et al. 2006), we found that separations shorter than 10 milli-parsec, which is roughly the required separations to generate thin slabs, do not happen frequently enough. This makes the formation of G2 through colliding winds an unlikely but possible scenario. IRS 16SW and other Wolf-Rayet *binaries* on the other hand are permanently at short stellar separations – it is possible that their winds can be radiative enough to generate such massive clumps in the Galactic Centre. We defer studying these systems numerically to a forthcoming work.

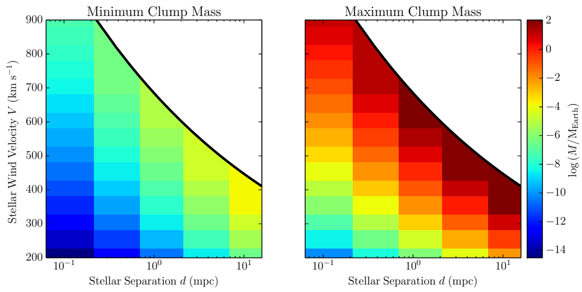

Fig. 1: Range of clump masses (colours) obtained with our model as a function of stellar wind velocity and separation. The left and right panels show the clump mass lower and upper limits, respectively.

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