Substellar population of the young massive cluster RCW 36 in Vela

A. R. G. do Brito do Vale[1,2], K. Mužić[2], H. Bouy[1], V. Almendros-Abad, A. Bayo, D. Capela, A. Scholz, A. Bik, G. Suárez, L. Cieza, K. Peña Ramírez, E. Bertin, R. Schödel

[1]Laboratoire d'Astrophysique de Bordeaux (LAB), Université de Bordeaux, Bât. B18N, Allée Geoffroy Saint-Hilaire CS 50023, 33615 PESSAC CEDEX, France

[2]Instituto de Astrofísica e Ciências do Espaço (IA), Faculdade de Ciências, Universidade de Lisboa, Ed. C8, Campo Grande, 1749-016 Lisboa, Portugal

Abstract. The exact shape of the initial mass function (IMF) down to the brown dwarf regime remains a fundamental yet contentious topic in the study of stellar formation and evolution. Understanding how different environments affect the formation of stars and brown dwarfs (BDs) is essential. RCW 36 is an embedded, young, massive cluster in the Vela Molecular Ridge ($\sim$1 kpc), with a stellar surface density comparable to the Orion Nebula Cluster, and is therefore well suited for testing the impact of such environmental effects on the IMF. We used deep HAWK-I/VLT near-infrared observations with ground-layer adaptive optics, complemented by 2MASS, SOFI/NTT, and Gaia DR3 kinematics to obtain the deepest census of the stellar and substellar populations in RCW 36 yet. Nebular emission was removed using the deep-learning algorithm DeNeb, improving source extraction and increasing the completeness down to $0.03\,M_{\odot}$. Membership weights were assigned through statistical comparisons of color–magnitude diagrams between RCW 36 and a control field, and individual masses were estimated from model isochrones. Employing the membership weights, we found a median of 426 members of RCW 36, including approximately 70–90 brown dwarfs. We determine the IMF ($dN/dM \propto M^{-\alpha}$) down to $\sim 0.03\,M_{\odot}$, described by a broken power law with a slope that is shallower than the Salpeter slope in the high-mass regime and a flatter slope of 0.46 ± 0.14 between $0.03\,M_{\odot}$–$0.20\,M_{\odot}$. The resulting star–BD ratio of 2–5 is consistent with those measured in other young Galactic clusters. Lastly, we also detect signs of possible primordial mass segregation.

Figure 1: HAWK-I/VLT color-composite image of RCW 36 (bottom right). Credits to Martin Kornmesser.