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Constraining particle acceleration in young massive compact star clusters with 3D MHD simulations.

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The number of young star clusters identified as sources of gamma-ray emission has been increasing in recent years, hinting at ongoing particle acceleration within these regions. The interaction between winds from massive stars can create collective shocks and lead to the formation of superbubbles (SBs), whose interior is filled with tenuous, hot, turbulent plasma. Characterising these environments can clarify the role of SBs in the Galactic CR ecosystem, in particular with regard to the origin of CRs beyond the knee. In Haerer et al. 2023, we propose that the ring-like TeV gamma-ray emission encircling the cluster on a ~20 pc scale is produced by inverse Compton emission from electrons accelerated at the cluster-wind termination shock. Both a hadronic model and alternative acceleration sites are disfavoured by the extent of the source and the overall energetics. In this study, we note the importance of environmental parameters, such as the magnetic field, which critically determines the maximum energy and particle transport in SBs. I will present 3D MHD simulations of star clusters, highlighting how interactions between individual winds lead to magnetic field amplification to >100 muG and the complex, highly heterogeneous magnetic field morphology. Furthermore, I will discuss how these results might impact particle acceleration and transport in young massive compact star clusters.

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