Contribution ID: **68** Type: **Original Talk**

Cosmic ray acceleration up to hundreds of TeV in young massive star clusters: 3D MHD simulations

Young compact clusters of massive stars contain dozens of O-, B and WR-type stars with fast powerful winds in a small ~ pc radius. The particle acceleration by ensembles of shocks and waves of compression and rarefaction in the turbulent environment of young massive star clusters (YMSCs) is an alternative to the standard paradigm of Galactic cosmic rays acceleration on supernova shocks. In recent years, the topic is of great interest due to the fact that modern gamma- and X-ray observatories are detecting the radiation from YMSCs (e.g. Westerlund 1, 2), which indicates particle acceleration processes in these objects. We study particle propagation and acceleration in a YMSC with the help of 3D magnetohydrodynamic (MHD) modeling using PLUTO, an open source code based on the numerical solution of MHD equations with the Godunov scheme [1]. The code allows modeling of the turbulent environment of YMSCs and obtaining crucial for particle acceleration values of velocity, density and magnetic field inside the cluster core [2]. The particle module implemented in PLUTO allows solving the equations of motion for test charged particles together with MHD equations for the medium. We obtained that protons acceleration up to hundreds of TeV takes place in the cluster core near the termination shocks of O-stars, which are surrounded by shocks of their neighbour stars. We also modeled an interesting case of a young supernova remnant expanding inside the cluster core. In this case a very fast acceleration takes place: particle energies >100 TeV can be obtained in <100 years. The particle spectra and spatial distribution are discussed.

[1] Mignone A, Bodo G, Massaglia S, Matsakos T, Tesileanu O, Zanni C and Ferrari A 2007 ApJS 170 228–242 (Preprint astro-ph/0701854)
[2] Badmaev D V, Bykov A M and Kalyashova M E 2022 MNRAS 517 2818 2830 (Preprint 2209.11465)

Primary authors: KALYASHOVA, Maria (Ioffe Institute); BYKOV, Andrey (Ioffe Institute); Dr BADMAEV, Danir (Ioffe Institute)

Presenter: KALYASHOVA, Maria (Ioffe Institute)

Session Classification: Cosmic rays (nuclei, gammas, neutrinos) of very high energies (> 100 TeV)

Track Classification: Cosmic rays (nuclei, gammas, neutrinos) of very high energies (> 100 TeV)