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Magnetic field amplification during stellar collisions and its implication for blue stragglers

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In dense stellar environments, stars can collide physically. Stellar collisions are known to play a key role in shaping the stellar population in the center of stellar clusters and galactic nuclei, as well as in creating exotic stars, such as blue stragglers, and electromagnetic transients. Previous studies on stellar collisions have mostly focused on the hydrodynamical effects on the properties of collision products. However, stars can be magnetized due to dynamo action in their convective regions or the inheritance of magnetic fields from the interstellar medium during their formation. Because magnetic fields can crucially affect the spin evolution and angular momentum transport inside stars, it is essential to understand possible magnetic field amplification during collisions and its impact on the long-term evolution of collision products. For instance, magnetic braking can provide a possible solution to the "angular momentum problem" for blue straggler formation, where excessive angular momentum inside collision products created by off-axis collisions would prevent them from settling into blue stragglers. To achieve this goal, we perform magnetohydrodynamics simulations of dynamical collisions between main-sequence stars in both globular and open clusters, using the state-of-the-art moving-mesh code AREPO. Our simulations suggest that magnetic fields can be amplified by more than ten orders of magnitude during collisions due to turbulent dynamo, resulting in strongly magnetized stars upon collision. We further investigate the long-term evolution of the magnetized collision products with magnetic braking using the 1D stellar evolution code MESA. I will discuss astrophysical implications of such significant magnetic field amplification in collisions for blue straggler formation and jetted tidal disruption events.

Affliation

Max Planck Institute for Astrophysics

Current Position

Postdoc

Primary author: RYU, Taeho (Max Planck Institute for Astrophysics)

Presenter: RYU, Taeho (Max Planck Institute for Astrophysics)

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