

## **Magnetic Field Generation Induced by Streaming Cosmic Rays**

Magnetic fields are observed in various length scales from the planetary scale to the scale of galactic clusters. A certain level of the magnetic field is implied even in the voids of large-scale structures by gamma-ray observations. However, the origin of magnetic fields has not been revealed yet. Here, we propose a new generation mechanism of magnetic fields where the Biermann battery effect is induced by streaming cosmic rays. Because the first cosmic rays are expected to be generated in supernova remnants of the first stars, this new mechanism can work just after the beginning of structure formation. We estimate the strength of the magnetic field achieved by this mechanism and show that it is sufficient for the seed of currently observed  $\mu\text{G}$ -level galactic magnetic fields. We compare this with the other previously proposed mechanisms and conclude that our new one dominates in relatively small-scale, low-temperature, and weakly-ionized regions.

**Primary authors:** YOKOYAMA, Shota (The University of Tokyo); Dr OHIRA, Yutaka (University of Tokyo)

**Presenter:** YOKOYAMA, Shota (The University of Tokyo)

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