

The role of magnetic mirrors in fusion research

Magnetic mirror confinement is one of the earliest approaches explored for magnetic confinement fusion. It confines plasma using magnetic fields that become stronger toward both ends of the confinement region. Its relatively simple geometry, potential for high-beta operation (a high ratio of plasma pressure to magnetic pressure), and suitability for continuous operation make it an attractive approach to fusion energy production. However, significant plasma losses through the open ends have long limited its confinement performance and development as a fusion reactor concept. Recent experimental advances, particularly those achieved in the Gas Dynamic Trap (GDT) in Russia, have renewed interest in magnetic mirrors as potential fusion reactors. Beyond their application to fusion energy production, magnetic mirror devices can also serve as neutron sources for fusion materials testing and as experimental platforms for studying plasma physics and developing technologies required for future fusion reactors. In this talk, I will first introduce the basic principles, advantages, and challenges of magnetic mirror confinement, along with recent progress in mirror fusion research. I will then discuss the broader roles of magnetic mirror devices in fusion research, focusing on the development of the KAIST Magnetic Mirror (KAIMIR) device and its applications to divertor plasma studies, plasma heating, and fast ion physics. Through these examples, I will highlight how magnetic mirrors can contribute to fusion energy development, both as potential reactors and as versatile experimental platforms.