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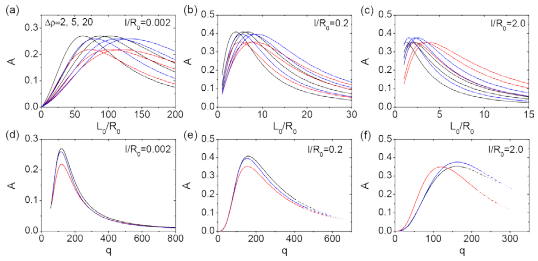
Invariant imbedding applied to equations for plasma dynamics helps understand wave motions found in the coronal loops of the sun.



How wave modes transform and couple energy in plasmas and how these transformations are affected by the inhomogeneous structure of plasma are crucial for understanding wave transport and absorption in studying plasma dynamics, especially magnetohydrodynamic wave propagation in the solar atmosphere. New research presents an innovative approach for approximating the real-world wave motions of the sun's coronal loop.

Yu and Doorsselaere report findings that scaling behavior is universal across a variety of density profiles regardless of a plasma's geometry and mode conversion. Applying an invariant imbedding method to ideal magnetohydrodynamics wave equations, they demonstrated that the scaling behavior is shared for several density models of a simulated plasma in a cylindrical geometry. The work expands their previous research in understanding coronal loop kink oscillations.

The results suggest the possibility of inferring the wave energy absorption from resonant absorption using observed parameters of the waves.

"The scaling behavior means that the mode conversion can be described as a single formula, which is a combination of wave parameters and medium parameters," said author Dae Jung Yu. "If we restrict the range of mode conversion in some region, scaling behavior can be a common feature."

Mode conversions occur in the inhomogeneous region near or at the loop boundary, called the transition layer. They are most efficient when the thickness of the transitional layers is kept small and the loop length of the cylinder is relatively large.

In their paper, the authors said that such findings could potentially apply to other forms of mode conversion described by wave equations, such as the conversion between electromagnetic and gravitational waves.

Yu predicts that universal scaling behavior exists for other kinds of waves and in spherical geometry.

Source: "Universal scaling behavior of resonant absorption," by D. J. Yu and T. Van Doorsselaere, *Physics of Plasmas* (2019). The article can be accessed at https://doi.org/10.1063/1.5111624.