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Ferrohydrodynamic Jets, Sheet Flows and Instabilities

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We investigate vertical ferrofluid jets of initially circular cross-section striking a solid circular impactor to create a radially expanding sheet flow in the presence of a magnetic field. With no magnetic field, the expanding sheet is circular. When a horizontal magnetic field transverse to the vertical jet axis is applied, the jet cross-section changes from circular to approximately elliptical with long axis in the direction of the magnetic field. The expanding sheet also becomes approximately elliptical but with long axis perpendicular to the magnetic field. If a nozzle of elliptical cross-section is used with non-magnetic fluid, the expanding elliptical sheet also has long axis perpendicular to the jet cross-section long axis. If the applied magnetic field is vertical, and thus perpendicular to the sheet interfaces, the expanding sheet radius decreases with increasing magnetic field. We demonstrate that in this geometry, the magnetic field destabilizes the sheet through amplification of the Kelvin-Helmholtz instability.

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