Cooling by hot magnons

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In this study, we introduce a refrigeration device that operates on the *cooling by heating* mechanism, where a quantum dot facilitates energy exchange between two ferromagnetic metals and a hot magnetic insulator. Magnons originating from the magnetic insulator propel energetic electrons from the colder to the hotter ferromagnetic electrode, thereby cooling the cold metallic lead. Our analysis shows that the coefficient of performance is determined by the quantum dot's energy level, the applied magnetic field, and the degree of electrode spin polarization. Maximum cooling efficiency occurs when the electrodes are fully spin-polarized and aligned in an antiparallel magnetic configuration. As spin polarization diminishes, however, a considerable parasitic heat current emerges due to the intrusion of spin-down electrons into the cold reservoir. This unwanted flow not only weakens the net cooling effect but also significantly restricts the temperature range over which the device can operate. Overall, our findings demonstrate that quantum dots provide a promising platform for magnon-mediated refrigeration and offer valuable guidance for the advancement of spintronic and quantum thermal technologies.