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A microwave trap for sympathetic cooling of polar molecules[1]

DEVIN DUNSEITH[2], STEFAN TRUPPE, RICHARD HENDRICKS, BEN SAUER, EDWARD HINDS, MICHAEL TARBUTT, Imperial College, London —

We have been developing techniques to cool molecules into the microkelvin regime. One method is to use sympathetic cooling, using ultracold atoms as a refrigerant to cool molecules. Previous work has suggested that atoms and molecules can be trapped in the antinode of a Fabry-Pérot microwave cavity. We couple microwave power into this cavity from a rectangular waveguide via a small hole in one mirror. We have developed an analytical model that helps us understand this coupling, and gives us an idea of how the size of the hole affects the cavity's coupling and finesse. We carried out finite–difference time–domain simulations and performed experiments on a prototype cavity to verify this model. We have now designed and built this trap for operation under ultra high vacuum, with the ability to cool the mirrors to 77 K and couple in up to 2 kW of microwave power. This will allow us to trap molecules with a moderate dipole moment at temperatures of hundreds of millikelvin, as well as atoms at a few millikelvin. We will present our work in creating and understanding the microwave trap, as well as our first results demonstrating trapping of lithium atoms in the microwave trap.

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[2]The first two authors contributed equally

Devin Dunseith
Imperial College, London

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