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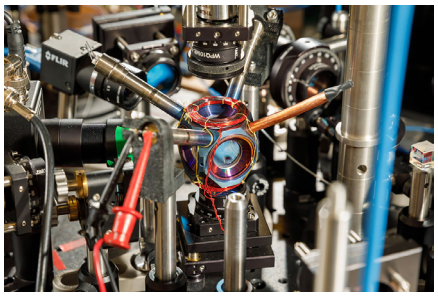
New vacuum technology for laser-cooled atoms reliably sustains cold atoms for over 200 days with no signs of degradation.



Miniaturizing vacuum technology for cold-atom sensors has attracted researchers' interest because of the potential applications, such as gravimeters, accelerometers, gyroscopes, clocks, and magnetometers. Using passive pumping to reduce the size and complexity of vacuum chambers for cold atom systems has been proposed but not previously demonstrated.

Little et al. provide the first demonstration that passive pumping can be used to make a vacuum system that can reliably sustain cold atoms for months with no sign of degradation.

Most vacuums have continuously running ion pumps to keep the pressure constant, which contributes significantly to the size and power consumption of the device. The researchers used a different method with porous getters "soaking up" the extra atoms through a process called sorption. They used a cloud of laser-cooled atoms inside the chamber to monitor the resulting vacuum.

"We were surprised by the degree to which the dispensers contributed to the pumping," said author Bethany Little. "The system was more complex than anticipated: in such a small volume, everything is thermally coupled, and the nearby dispensers had a surprisingly important pumping effect."

Passive pumping is already in use in ion clock technologies. This demonstration, however, represents a more stringent requirement for vacuums, since small atoms such as helium, commonly used as a buffer gas in ion traps, would prevent the cooling of neutral atoms if they were to permeate the vacuum windows.

"These findings could be particularly useful for applications sensitive to magnetic fields, since we have removed the need for strongly magnetic ion pumps," said Little.

This method could reduce the power and size requirements of cold atoms-based devices for quantum technologies, such as quantum sensors, and enable their wider applications.

Source: "A passively pumped vacuum package sustaining cold atoms for more than 200 days," by Bethany J. Little, Gregory William Hoth, Justin Christensen, Chuck Walker, Dennis J. De Smet, Grant W. Biedermann, Jongmin Lee, and Peter D. D. Schwindt, *AVS Quantum Science* (2021). The article can be accessed at https://doi.org/10.1116/5.0053885.