Scilight

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Panopticon: not a Transformer, but transforming ion trapping technology

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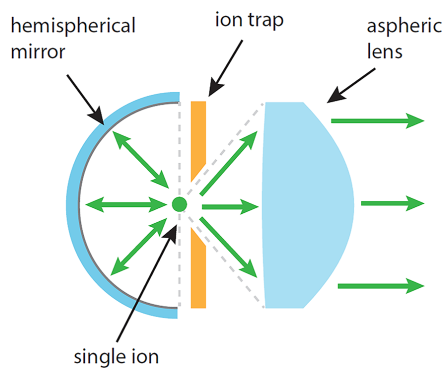
A combination of a hemispherical mirror and unique ion trap design allows for the observation of quantum electrodynamics effects in complex systems.



The ability to observe the spontaneous emission behavior of atoms can aid in the study of many quantum electrodynamics (QED) phenomena. Looking for a way to measure these emissions, Araneda et al. designed a unique mirror-integrated ion trapping system, which they named “Panopticon.”

“If you have a single emitter in front of a mirror and the wave gets reflected – if your atom is exactly at the node of the standing wave – the wave destroys itself and the photon can never be emitted. If you move the mirror half a wavelength, you have the opposite effect and you see twice as many photons as you’re supposed to,” said author Gabriel Araneda. “We’re designing this setup for those purposes.”

A hemispherical mirror and 3D-printed trap are the main components of the Panopticon system, working together to enhance and inhibit spontaneous emission and observe QED effects at unprecedented precision. The hemispherical mirror exhibits surface error smaller than 25 nanometers within its 12.5-millimeter radius of curvature. Rather than being assembled from different components, the ion trap uses a non-standard subtractive 3D printing technique in which a dielectric substrate is carved into the desired shape using a laser, with trenches separating electrodes from one another.

The Panopticon can simultaneously trap up to 20 ions, allowing researchers the flexibility to suppress spontaneous emission in complex systems for potential quantum computation applications.

“You can store information in an atom, but because the atom emits, that information is released to the environment,” Araneda said. “If we could inhibit the spontaneous emission totally, that information inside the atom could live much longer.”

Source: “The Panopticon device: An integrated Paul-trap-hemispherical mirror system for quantum optics,” by G. Araneda, G. Cerchiari, D. B. Higginbottom, P. C. Holz, K. Lakhmanskiy, P. Obšil, Y. Colombe, and R. Blatt, *Review of Scientific Instruments* (2020). The article can be accessed at https://doi.org/10.1063/5.0020661.