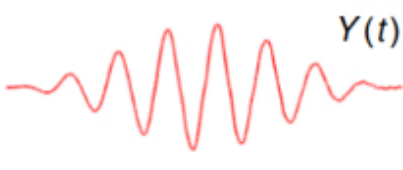
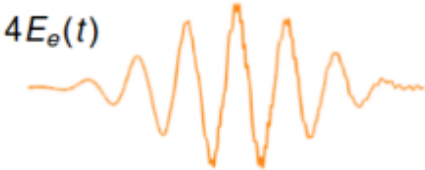
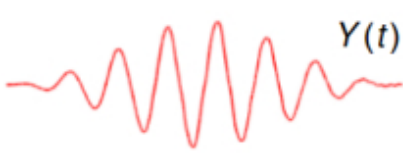
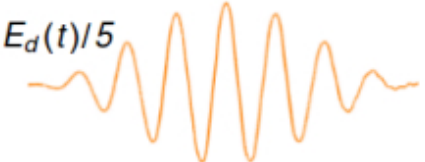
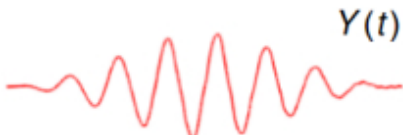
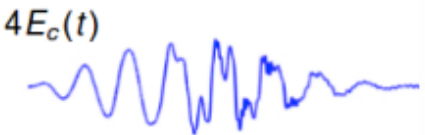
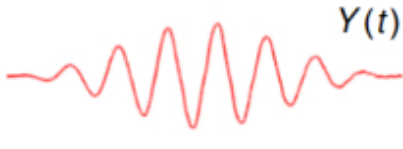
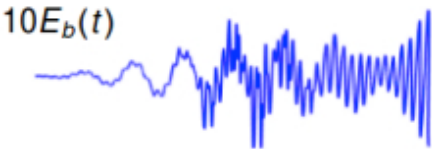
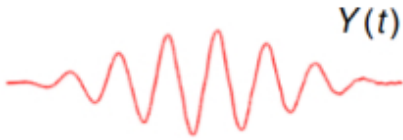
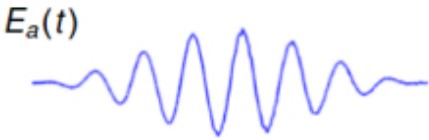
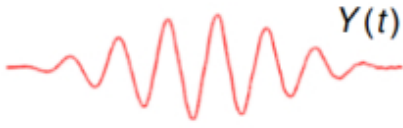
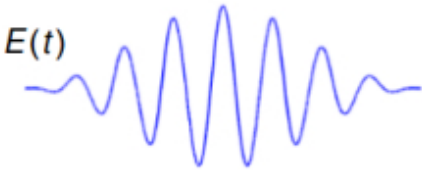


Proposed method to cause an atom to emit the same light as another atom

February 27 2017, by Bob Yirka



The control fields $E_a(t)$, $E_b(t)$, $E_c(t)$, $E_d(t)$ and $E_e(t)$ induce the same nonlinear optical response $Y(t)$ on: closed quantum systems (a) and (b), (c) an open quantum system, (d) an closed classical system and (e) an open classical system. In (a) and (b), the system is a hydrogen atom initially prepared in the ground and first excited states, respectively. $E_b(t)$, $E_d(t)$ and $E_e(t)$ are scaled for comparison with the first field $E(t)$ that is applied to a model of an argon atom to produce the induced dipolar spectra $Y(t)$, which is used for tracking in the remaining cases. Credit: arXiv:1611.02699 [quant-ph]

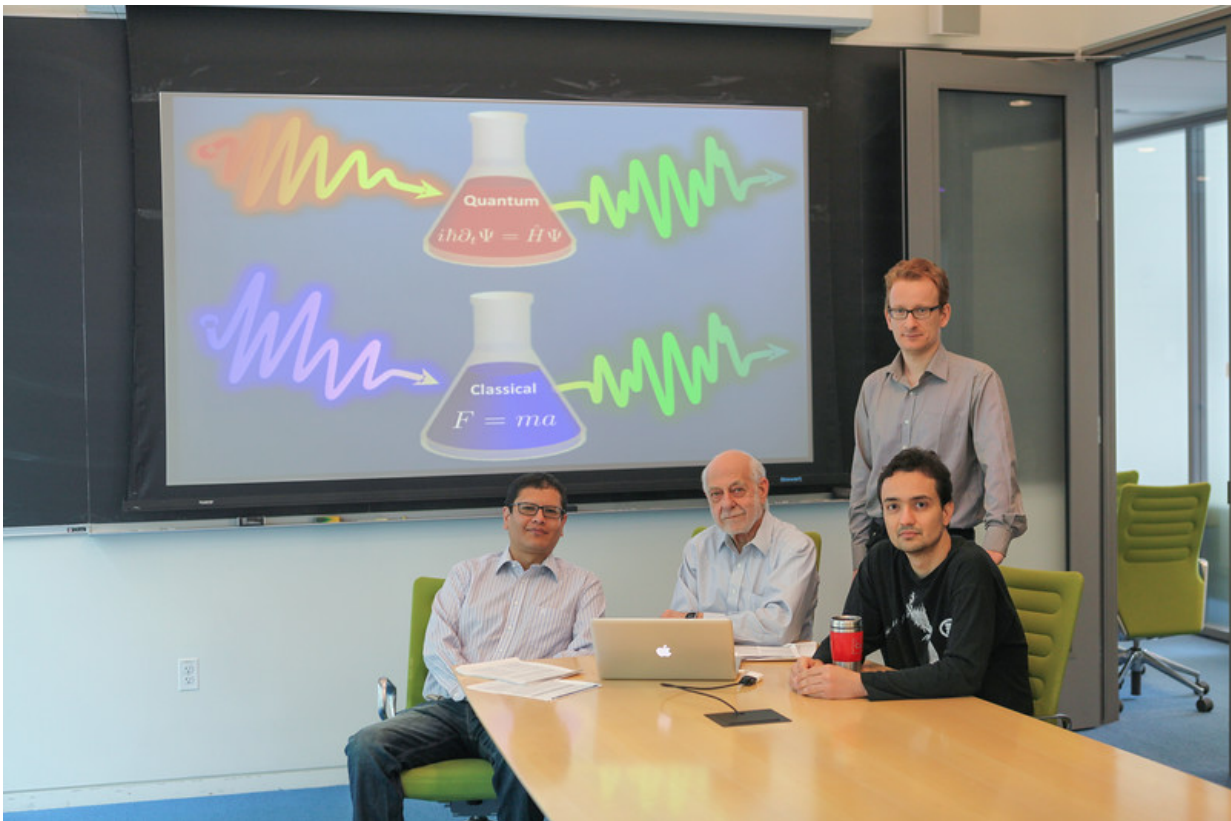
(Phys.org)—A team of researchers at Princeton University has found a way to cause any atom to mimic the light emissions of any other atom. In their paper published in the journal *Physical Review Letters*, the team reveals how they uncovered this trick and suggest some applications that might benefit from its use.

Scientists in a variety of fields measure the [light](#) emitted from atoms when their electrons move between [energy levels](#) to identify the presence of an element—astronomers, for example, can detect the presence of argon in a star by noting the unique signature of light that it emits. But it turns out that under certain circumstances, atoms can be induced to impersonate other atoms. In this effort, the researchers found that by manipulating the light that was fired at a given atom, they could cause the atom to emit the signature of any other atom.

They could cause an argon atom, as just one example, to emit the same wavelength of light as a hydrogen atom by shaping the pulse of [laser light](#) that was fired at the atom. More importantly, the same technique could also be used to control the quantum state of the targeted atom. Using light to make atoms do things is not new, of course; quantum control has been used, for example, to cause chemicals to react in desired ways for quite some time. But using light to control the state of an atom could provide the basis for new applications—molecules that

emit different colors, for example, to distinguish them in biological processes.

The researchers started with the idea of controlling the state of an atom using light by building a model that demonstrated that a single pulse of light could bring about any one of an infinite number of atomic states, some of which would be ionized—and changing an atom's state in a certain way, it was noted, could cause a change in the wavelength of light that it emitted. To calculate which pulse shape would produce the desired wavelength, the researchers used the Schrödinger equation. It should be noted that the idea is still theoretical; the researchers did not actually cause any [atoms](#) to mimic others—that will require work by an experimental team.



Study co-authors from left to right: Renan Cabrera, Herschel Rabitz, Denys Bondar, and Andre Campos Credit: C. Todd Reichart, Department of Chemistry at Princeton University

More information: Andre G. Campos et al. How to Make Distinct Dynamical Systems Appear Spectrally Identical, *Physical Review Letters* (2017). DOI: [10.1103/PhysRevLett.118.083201](https://doi.org/10.1103/PhysRevLett.118.083201) , On Arxiv: arxiv.org/abs/1611.02699

ABSTRACT

We show that a laser pulse can always be found that induces a desired optical response from an arbitrary dynamical system. As illustrations, driving fields are computed to induce the same optical response from a variety of distinct systems (open and closed, quantum and classical). As a result, the observed induced dipolar spectra without detailed information on the driving field are not sufficient to characterize atomic and molecular systems. The formulation may also be applied to design materials with specified optical characteristics. These findings reveal unexplored flexibilities of nonlinear optics.

[Press release](#)

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