Beyond the classical view of atoms

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Regardless of which turns out to be more accurate in physics experiments or more complete in mathematical description, the two theories overlap with regard to physical chemistry. Therefore, I propose that introductory chemistry taught in secondary schools can be rationalized as easily by references to SED as to QED.

Either theory produces identical predictions for many experiments involving second-order correlations, squeezing (quadrature noise reduction), and the original Einstein-Podolsky-Rosen proposal.[5] However, SED is not completely equivalent to QED on a mathematical or physical level. The SED Schrödinger equation is incomplete, because there is a companion equation that has no counterpart in ordinary quantum mechanics and restricts initial conditions.[3] Furthermore, the predictions of QED and SED are different with regard to high-order correlations in nonlinear optics.

I agree fully with Grujić and Simonović that the classical atom is alive and well. Models of the atom based on SED are sufficiently accurate for many technological and most pedagogical applications. Even if the classical atom isn't the most fundamental description of the physical world, it is still an important one.

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■ **In their article,** Petar Grujić and Nenad Simonović emphasize the value of the classical description of atoms in yielding simplicity, conceptual clarity, and analytical treatments of complex problems involving various atomic interactions. Quantum mechanics can often yield more accurate results, but at the expense of clarity, simplicity, and sophistication. A similar situation exists with our classical treatment[1,2] of the work function of metals and the original quantum mechanical treatment by Eugene Wigner and John Bardeen.[3]

Consider the correspondence between the ionization potential of free, gaseous atoms and the work function of solid metals. Both are really ionization energies, only applied to different entities (atoms and solids) and artificially given different names. But both can be defined generically as the energy required to remove from the entity the most loosely bound electron(s) to infinity at rest, as Niels Bohr rigorously did for atoms.

The conceptual clarity offered by classical methods can yield comparatively easy extensions to more complex situations. For example, a generic dependence of the ionization energy on a solid's size (particularly in the case of small particles) has been established and subsequently confirmed by experiments.[4,5]

Thus, consistent with the concepts put forward by Grujić and Simonović, simple classical concepts are also useful and valuable to treat complex phenomena such as the work function of metals and insulators, particle charging, triboelectric charge exchange, and so forth.

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An early start for superfluid applications in geodesy

I thoroughly enjoyed the article "Superfluid helium interferometers," by Yuki Sato and Richard Packard (PHYSICS TODAY, October 2012, page 31), but I was surprised and a bit mystified by the closing comment: "Two decades ago no one would have expected that superfluids could find application in geodesy to probe variations in Earth's rotation, yet the application is becoming a feasible reality today." I admit I had to refresh my memory by referring to the proceedings of an American Geophysical Union Chapman Conference that I had organized in 1991, but sure enough, among the papers presented was one titled "The superfluid helium gyroscope: An emerging technology for Earth rotation studies."[1]

In 1991 the geodetic community was still refining the new International Earth Rotation Service (IERS), which had debuted in January 1988. As chief of the advanced technology branch of the Geosciences Laboratory at the National Oceanic and Atmospheric Administration and principal coordinator for the IERS very long baseline interferometry center, I was leading the operation of a global network of VLBI observatories to regularly determine Earth's nutation, polar motion, and variations in rate of rotation.[2] Funding constraints limited the number and length of VLBI observing sessions we could do, and I was looking for an alternative way to continuously monitor changes in Earth's rotation rate with as high a temporal resolution as feasible—hopefully, a few hours or less. Based on information then available, both superfluid and ring-laser gyroscopes appeared potentially capable of meeting our goals. After contacting and consulting with Packard, I initiated a research grant for him to develop a superfluid gyroscope explicitly designed for monitoring Earth's rotation.[3]

Unfortunately, management changes at NOAA after Bill Clinton was elected president in 1992 soon cut off funding for the superfluid gyroscope and, just a few years later, for the NOAA VLBI program as well. I had not kept track of work on superfluid gyroscopes during the ensuing years, but apparently, more than two decades later, the superfluid gyroscope is just now "becoming a feasible reality." Still, the world of superfluid helium and Packard's research into it remain undeniably fascinating.

References

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