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LET THERE BE LIGHT: THE HINDU EDITORIAL ON THE 2023 PHYSICS NOBEL

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According to the laws of quantum mechanics, the observable properties of electrons in matter — like a fruit or a rock — change in a few hundred attoseconds. One attosecond is 10^{-18} seconds. To study these extremely rapid changes, special tools are needed, and Anne L'Huillier, Pierre Agostini, and Ferenc Krausz have received the 2023 physics Nobel Prize for building these tools. From the late 1980s, Dr. L'Huillier led several studies that found that an infrared beam shone on a volume of a noble gas produced multiple overtones: waves whose wavelength was an integer-fraction of the 'original' light wave. Her team also observed a peculiar relationship between the original wave's frequency and the intensity of the overtones, and explained it using the existing laws of quantum mechanics — a milestone. If the overtone waves' peaks lined up, they would combine to produce a more intense peak (constructive interference); when one wave's peak coincided with another's trough, they would cancel themselves out (destructive interference). Physicists realised that this reinforcing effect could be timed such that the gas emitted intense peaks with a pulse duration of a few attoseconds, with destructive interference achieving the cut-off. Dr. Agostini and company demonstrated this in 2001 by producing light with a pulse duration of 250 attoseconds. In the same year, Dr. Krausz and company isolated a single pulse, 650 attoseconds in duration, and used it to measure the kinetic energy of electrons kicked out from krypton atoms by a bunch of photons. Attosecond physics had finally arrived.

The medicine Nobel Prize this year celebrated the invention of mRNA vaccines and their effect on the COVID-19 pandemic. The utility for people here was straightforward, whereas that for attosecond physics is not. However, the absence of evidence is not evidence of absence. The specific dynamics of electrons matter in settings with potentially immediate value, including biochemistry, diagnostics, superconductivity, and manufacturing techniques. Thanks to the laureates' work, scientists have a way to illuminate hitherto unknown possibilities with discoveries of phenomena that live and die in attoseconds. Then again, humans rarely have all the information required to judge whether a particular discovery or invention could be of value later. The 2016 chemistry laureates were feted for building motors with individual molecules — a feat with no known applications at the time, but to achieve it, they devised techniques that improved other areas of chemistry. To paraphrase one of these laureates, J. Fraser Stoddard, there is important value in making something that was hard to do before easier to do today, and "we still have the excitement of finding out what [its applications] might be".

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