Linked by light

Since the late 19th century, when Max Planck modelled radiation emitted by a black body, the idea that light has a particle nature has come a long way. Albert Einstein won a Nobel prize in 1921 for his paper on the photoelectric effect, in which he developed the idea of light as quanta, or photons. For a long time after this, scientists were mainly interested in the quantum theory of matter.

The development of laser science made possible the study of light as governed by quantum theory. Important contributions to statistical properties of light were made by scientists such as E.C.G. Sudarshan and Roy Glauber. Today, quantum optics powers many discoveries and its full potential can only be guessed at.

The most ambitious attempt to date to unpack this potential might come from a paper entitled: “Light, the Universe and everything – 12 Herculean tasks for quantum cowboys and black diamond skiers”. Its 32 authors from 10 countries (three of them Nobel Laureates) attempt to set benchmarks in the field of quantum optics.

The paper, a first-of-its-kind activity, touches on recent findings such as detection of gravitational waves by the team at LIGO, or the Laser Interferometer Gravitational-Wave Observatory, that literally shook the world in 2015. It also dwells on exotic subjects such as the “time crystal”, and the importance of “nitrogen-vacancy centers in diamond”, which can help in building quantum computers of the future.

Crystals are solids that show a repeating arrangement in space of a basic structure known as the unit cell. Time crystals (systems that repeat their crystal structure not just in space but also in time) were first proposed by Frank Wilczek, one of the authors of the paper, and who also shared the 2004 Nobel Prize in physics.

In 2017, time crystals were demonstrated in a laboratory setting. “A beating heart is a time crystal in the broadest, purely mathematical sense,” writes Professor Wilczek in the paper. The questions he poses for research are around whether there are time liquids, glasses and quasicrystals and whether we could imagine a world where there is a time-dependent parallel to the properties of crystalline solids that we know.

Astrophysics aficionados may be thrilled by Nobel physicist, Rainer Weiss’s contribution to the paper as well; he explores what gravitational waves might reveal about black holes, neutron stars and supernovae.

Climate change and global warming are addressed by Prof. Goong Chen in the section, “What is the most urgent undertaking in science and technology?” He asks whether it is possible to “mimic, speed-up or even improve” photosynthesis by making use of nonlinear shortcuts to the chemical processes of carbon capture.

Plans for future research that the authors have outlined could excite not only scientists but also science enthusiasts and sci-fiction writers across the world.

The writer is a science editor at The Hindu in Chennai

Sign up to receive our newsletter in your inbox every day!

Please enter a valid email address.

This refers to the tendency to form friendships and other forms of interpersonal relationships with people we come across often in our daily lives.

END