PHYSICS WEBINAR REPORT

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Title:
SPEAKER 1: THE WONDERFUL WORLD OF MATERIALS- PROF. SAMIT KUMAR RAY
SPEAKER 2: EXPERIMENTAL PHYSICS FOR UNDERGRADUATE STUDENTS- PROF. AMAL KUMAR DAS

About the webinar:

Materials science, the study of the properties of solid materials and how those properties are determined by a material's composition and structure. It grew out of an amalgam of solid-state physics, metallurgy, and chemistry, since the rich variety of materials properties cannot be understood within the context of any single classical discipline. With a basic understanding of the origins of properties, materials can be selected or designed for an enormous variety of applications, ranging from structural steels to computer microchips. Materials science is therefore important to engineering activities such as electronics, aerospace, telecommunications, information processing, nuclear power, and energy conversion.
Physics, and natural science in general, is a reasonable enterprise based on valid experimental evidence, criticism, and rational discussion.It provides us with knowledge of the physical world, and it is experiment that provides the evidence that grounds this knowledge. Experiment plays many roles in science. One of its important roles is to test theories and to provide the basis for scientific knowledge.

Speaker with designation:

Speaker 1:

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Number of virtual audience: Approx 130

Write up by the speakers:

scientists at the University of Darmstadt in Germany succeeded in stopping light completely inside a crystal. Some rays of light (in this case from a laser) were barreling along at the universal speed limit of 300 million meters per second — and then, when they entered the crystal, the waves simply stopped dead. These photons can remain stored inside and retrieved from the crystal for up to a minute, effectively creating the first feasible light memory, for use in long-range quantum networks. This breakthrough was only possible because of the crystal that they used — and the crystal could be created due to recent advances in materials science.

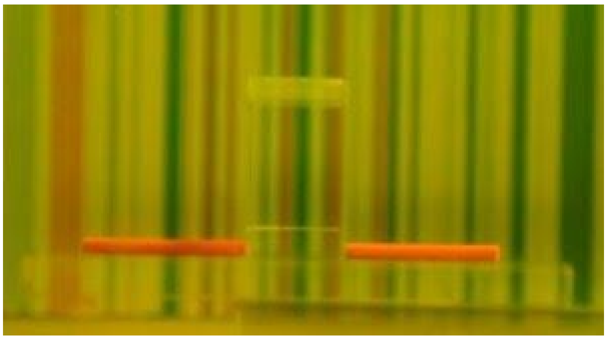
Materials science, sometimes known as materials engineering, is the study of the properties of matter. More succinctly, it is the study of how the structure of a material at an atomic scale affects its properties. Because materials science relies on being able to inspect and manipulate matter at a nanoscale, and our machines and tools are only just starting to reach the necessary levels of finesse and fidelity, this is a relatively new field. Thus, the last few years have been disproportionately exciting as scientists and engineers finally discover why and how materials behave the way they do — and perhaps more importantly, use their newfound knowledge to create new materials that behave in weird and wonderful ways.

n the case of the light memory crystal, the new material being used is yttrium silicate, doped with praseodymium (a rare earth element). We'll discuss doping in more detail later. This crystal has been specifically engineered so that it is transparent, but only when it's struck by a laser (electromagnetically induced transparency, or EIT, if you want to know the technical term). When it isn't illuminated, it becomes opaque. Thus, light from a second source (such as digital data being fed into the crystal from a fiber-optic cable) can be trapped inside the crystal.

Fairly wondrous, you might think, but materials science has furnished us with so many semi-magical materials in the last few years that stopping light almost seems mundane. Graphene, carbon nanotubes, molybdenite, metamaterials, self-healing oleophobic coatings — these materials, which are generally referred to as wonder materials, could revolutionize everything from computer chips to space exploration, and even allow the creation of invisibility cloaks.

Wonder materials

Because there's almost an infinite number of ways of arranging atoms and other nanoscale features (such as tiny, nanometer-scale grooves and whirls), wonder materials can assume any number of weird and wonderful properties. Graphene, which has hardly skipped a news cycle since its discovery in 2004, is the strongest and most electrically conductive material known to man — and yet all it is is a single layer of carbon atoms, mechanically exfoliated (a scientific euphemism for "removed with a piece of sticky tape") from a piece of graphite (as found in your pencil lead).



Despite its fantastical characteristics, though, graphene's properties are entirely down to mother nature, and the ubiquitous carbon-carbon bond (without which, life wouldn't exist). Metamaterials, on the other hand, are materials that have been engineered to have properties that absolutely don't exist in nature — such as negative refraction. By creating patterns and pathways that are exactly the right shape and size to bend and contort a specific frequency of light waves, you can make light behave in exceedingly peculiar ways. Generally, when light transitions from one medium to another (say, from air into water), it always refracts in a very specific way (skewing how things appear under water, for example). Negative refraction allows light to be bent in the opposite way, seemingly breaking Snell's law, which has existed in some form or another for over 1000 years.

The discovery of negative refraction has led to the creation of the first handful of invisibility cloaks, which seamlessly bend light and other electromagnetic radiation around an object. These cloaks aren't yet practical — they're large and unable to leave the laboratory — but it probably won't be too long until metamaterials provide you with a Harry Potteresque invisibility cloak.

Physics, and natural science in general, is a reasonable enterprise based on valid experimental evidence, criticism, and rational discussion. It provides us with knowledge of the physical world, and it is experiment that provides the evidence that grounds this knowledge. Experiment plays many roles in science. One of its important roles is to test theories and to provide the basis for scientific knowledge.[1] It can also call for a new theory, either by showing that an accepted theory is incorrect, or by exhibiting a new phenomenon that is in need of explanation. Experiment can provide hints toward the structure or mathematical form of a theory and it can provide evidence for the existence of the entities involved in our theories. Finally, it may also have a life of its own, independent of theory. Scientists may investigate a phenomenon just because it looks interesting. Such experiments may provide evidence for a future theory to explain. [Examples of these different roles will be presented below.] As we shall see below, a single experiment may play several of these roles at once.

If experiment is to play these important roles in science then we must have good reasons to believe experimental results, for science is a fallible enterprise. Theoretical calculations, experimental results, or the comparison between experiment and theory may all be wrong. Science is more complex than "The scientist proposes, Nature disposes." It may not always be clear what the scientist is proposing. Theories often need to be articulated and clarified. It also may not be clear how Nature is disposing. Experiments may not always give clear-cut results, and may even disagree for a time.

In what follows, the reader will find an epistemology of experiment, a set of strategies that provides reasonable belief in experimental results. Scientific knowledge can then be reasonably based on these experimental results.