

Hold a Moonbeam in Your Hand
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Every fan of *the Sound of Music* knows the Maria lyrics by the nuns: how do you hold a moonbeam in your hand. Yes, almost everyone takes for granted that light is unstoppable. And according to Maxwell and Einstein, this is correct: traveling at 670 million mph in vacuum, light sets the unbreakable speed record for all moving objects.

Even in a medium, light is a fast runner. Water, for example, only slows light down by 25%. Index of refraction is what physicists use to show how many times slower light travels inside a transparent material. For natural materials, index refraction can be as high as 5, yet light still orbits the earth 1.5 times a second at such speed. However, anything can be made possible by physicists. In 1999, a team at Harvard slowed a laser beam down to 17 m/s ^[1], slower than the speed limit on highways! Two years later, the same group froze light completely for one thousandth of a second ^[2], before releasing it again as the fastest runner. Physicists really held a moonbeam in their hands!

The magic control of light was achieved inside a cloud of sodium atoms. Just think of these atoms as a weird kind of water whose optical properties could be manipulated! Besides the target laser, there was a much stronger laser shining into the atomic cloud. This beam, known as the control light, acted like a switch. Once it was turned on, the atoms exhibited an index of refraction millions of times larger than usual, so that the target beam was slowed down considerably. The rear of the beam entered the atomic cloud slightly later, so it was slowed down shortly after the head. During this time difference, the rear almost caught up with the head. Because of this, the length of the beam was drastically shortened, so that it could fit entirely into the atomic cloud, whose size was merely a few millimeters! When the control light was turned off precisely at this moment, instead of restoring to its original state, the target light interacted with the atoms and was locked inside the atomic cloud. In other words, the light was stopped! When the control light went back on again after a while, the target light slowly moved out of the medium, recovered its length, and continued to travel at 670 million mph. The theory behind this control of light is very complicated. Its basic idea can be more or less described as a competition, or technically speaking, interference, between the two lasers interacting with the atoms.

Although it sounds distant from daily life, this phenomenon has great potential applications. Light is the ideal carrier of information due to low cost, perfect stability and high capacity of optical fibers, which are already widely used around the world. But information carried by light has to be converted into electronic signals for processing, mainly because of the difficulty in light storage. This conversion step is inefficient. It limits the speed of the Internet, the quality of Skype calls and the power of our computers. If light stopping technique is commercialized, signal processing can be done directly in the form of light. Online football streaming can be made much smoother, and movies can be downloaded within seconds! Of course, for physicists, there is still a long way to go. But let's be prepared for a big surprise one day, possibly in the very near future.

References: [1] Hau *et al.*, Nature **397**, 594 (1999). [2] Hau *et al.*, Nature **409**, 491 (2001).