Long-Range Motion of Excitons in Semiconductor Chips

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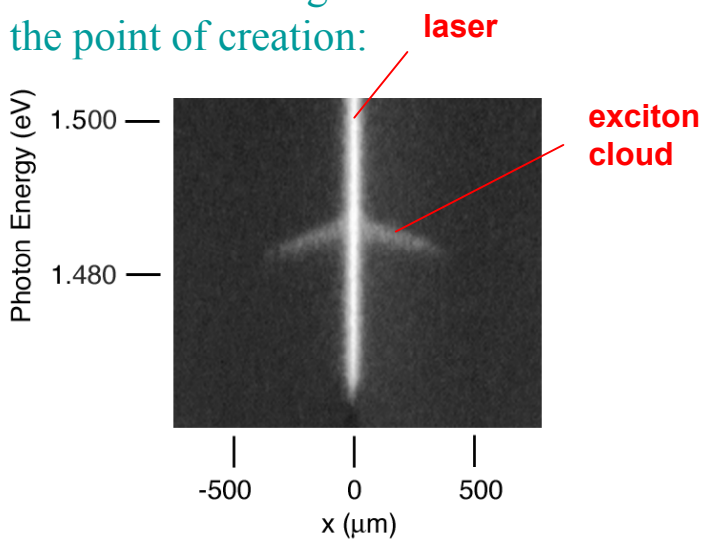
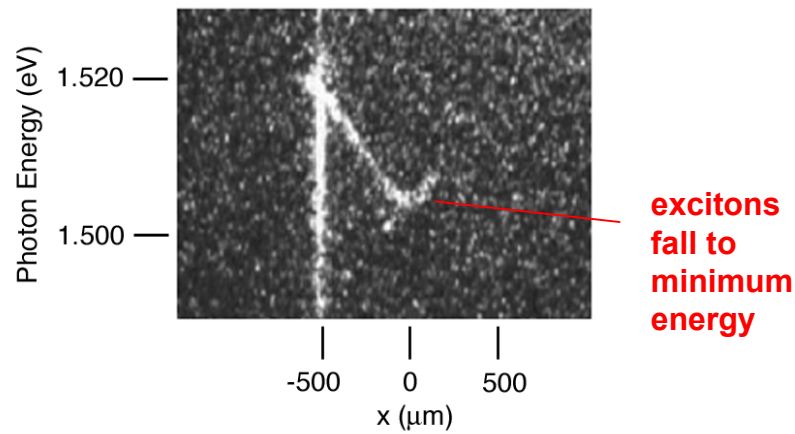
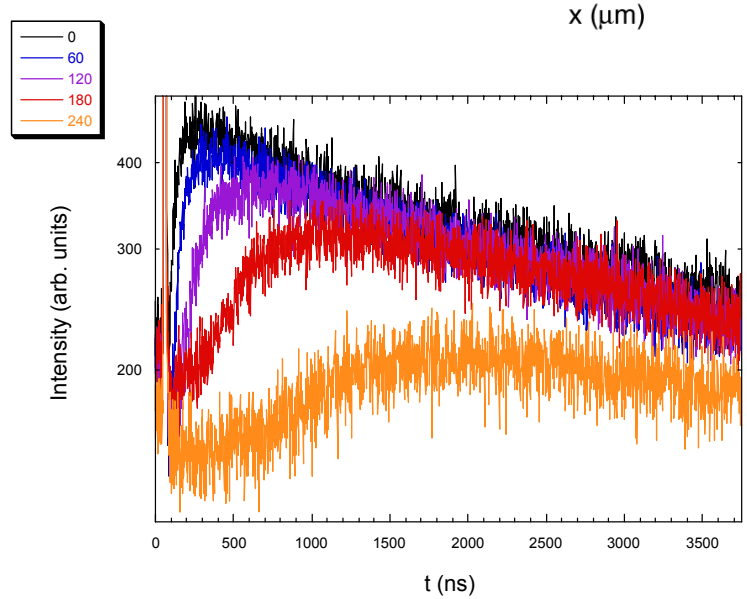
A cloud of excitons moving out from the point of creation:



Excitons moving down into a trap:



Time-resolved data: arrival of excitons at points up to 240 microns away



“Excitons” are energy particles which exist in semiconductors. Photons (light particles) can be converted into excitons when light is absorbed. Unlike photons, excitons have mass, and act like a gas of atoms moving around inside the semiconductor crystal. Eventually the excitons turn back into photons which are emitted from the medium. This emitted light allows us to see where the excitons go.

We have developed methods of extending the lifetime of excitons in semiconductor chips so that they can move hundreds of microns. We can also control where they flow, causing them to flow from one place to another. One can therefore imagine “excitonic circuits” where light energy, instead of charge, moves through semiconductor chips.

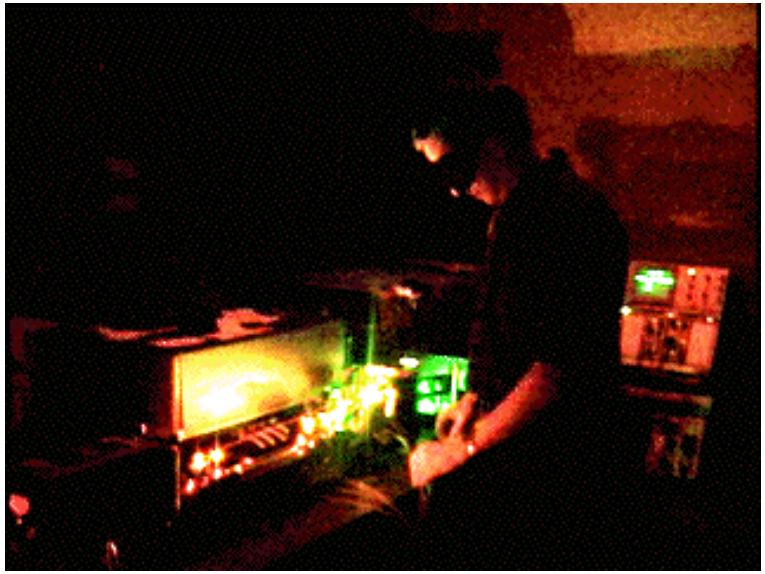
In the above data, a laser creates the excitons in a tiny spot (the laser leads to a broad emission of light, which appears as a vertical line in the images.) The excitons then move outward from the laser spot, exactly like a gas expanding.

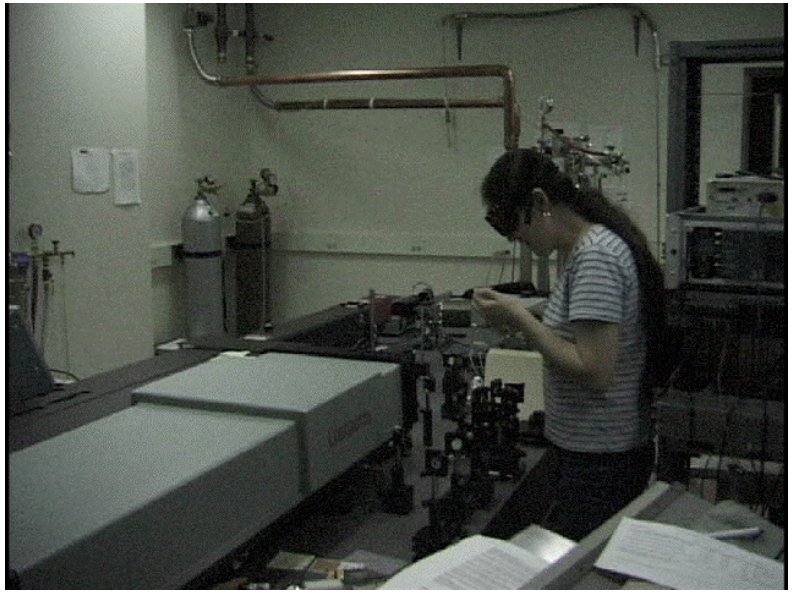
The semiconductor chip structures were produced by L. Pfeiffer and K. West of Bell Labs. Data was presented at the recent International Conference on Spontaneous Coherence in Excitonic Systems, (May 2004, Champion, PA) sponsored jointly by NSF and DARPA.

Photonics Education at the University of Pittsburgh

D. Snoke, University of Pittsburgh, DMR-0404912

Since 2001, the University or Pittsburgh has had a Certificate in Photonics program, supported by NSF. This program teaches undergraduates modern optical methods including lasers, fiber optics, nonlinear optics, and semiconductor optics. Students in Physics, EE, or Chemistry take courses in four departments to earn the certificate.





Societal impact: these students move directly into jobs in the photonics industry, which has had a downturn in the past two years but is now rapidly rebounding. Many also go on to grad school.

The Certificate in Photonics program at the University of Pittsburgh involves 6-7 courses beyond the normal course requirements for Physics, Chemistry,

or Electrical Engineering majors, including three new courses created specially for this program. The NSF grant also provides funding for undergrads to work in research labs in the summer. The program is viewed by the students as an elite program; we have had 14 students complete the certificate

in the past three years.

The need for qualified workers in photonics has been driven home by the experience of a local photonics company, Brashear. They are seeking to

hire 19 new staff but since they must be US citizens they have been unable to fill all these positions. They agressively recruit students completing

our program.

Several grad students have also been supported by this grant, including Yingmei Liu, who will be doing a postdoc with Wolfgang Ketterle at MIT starting this fall.