Vito Scarola, J Laser Opt Photonics 2018, Volume 5
DOI: 10.4172/2469-410X-C5-034

International Conference on
PHOTONICS, OPTOELECTRONICS AND DISPLAY DEVICES
&
International Conference on VEHICLE FIBER-OPTICS AND PHOTONICS
September 19-20, 2018 | Philadelphia, USA

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Optical signatures of excitations in fractional quantum hall states

Semiconductors have been processed into new tools for fundamental science by confining electrons to a nearly two-dimensional layer. A prominent discovery in this context found that magnetic fields quantize resistance measurements into rational fractions, the fractional quantum Hall effect. The fractions that were first observed had odd denominators. We now have a fairly good understanding of these odd-denominator states in terms of the composite fermion theory. The theory shows that excitations can be thought of as quantum Hall rotons. I will review calculations performed in our group that compare excitation energies of quantum Hall rotons to optical measurements. We find that the composite fermion theory gives an excellent description of the roton excitations observed optically at odd denominators. I will also discuss the observation of an even-denominator state, the 5/2 state, that led to a controversy that has yet to be settled. Hypotheses put forward include a topological state with the remarkable property that its excitations can be quantum entangled simply by moving them around each other. Some studies are consistent with this interpretation, but some are not. Our modeling definitively shows that realistic sample parameters do, in certain regimes, allow this remarkable topological state to manifest. I will also discuss related quantum correlated states while discussing potentially observable optical properties.

Biography

Vito Scarola completed his PhD at Pennsylvania State University, State College. He is now an associate professor of physics at Virginia Tech. He is a DARPA Young Faculty Award winner and has published more than 50 papers.

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