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Research Highlights

Nobel Prize 2009: Kao, Boyle & Smith

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The 2009 Nobel Prize in Physics has been awarded to Charles K. Kao for the development of optical fibres for telecommunications, and to Willard S. Boyle and George E. Smith for the invention of charge-coupled device sensors.

The first half of the prize recognizes Charles Kao for research that led to a drastic increase in the distances over which light can be transmitted by means of an optical fibre. It has been known since at least the nineteenth century that light can be guided within jets of water or thin cylinders of glass as a result of total internal reflection. Early in the twentieth century, researchers had investigated the use of bundles of glass fibres to transmit multiple rays of light for remote imaging. But optical losses in the glass from which these fibres were made meant they could practically transmit light over distances of only tens of metres or so.

In 1966, Kao identified that the single most important cause of this loss was absorption and scattering of light by impurities in the glass[1]. This prompted scientists to focus more closely on the material properties of optical fibres, and led eventually to the development of fibres capable of transmitting light over thousands of kilometres at a time.

The second half of the prize is shared by Willard Boyle and George Smith for their invention of charge-coupled device (CCD) sensor arrays[2,3], which are used in most modern high-performance digital imaging systems, such as those on the Hubble Space Telescope.

The key to the CCD's success is its simplicity. The basic structure of a CCD array is a string of metal oxide semiconductor capacitors placed side-by-side on a silicon chip. When light falls onto this array, its absorption by the silicon generates a charge on each of the capacitors that is proportional to the amount of light absorbed. By applying a sequence of different voltages to neighbouring capacitors, the charges on each can be passed from one to the next, like packages along a conveyor belt.

From the size of each package of charge passed to the end of an array, it is possible to determine the amount of light that illuminated each capacitor before the conveyor belt was started. And by simply placing many individual linear CCD arrays next to each other in parallel, a two-dimensional imaging array can be built.

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