PHYSICS AND ASTRONOMY COLLOQUIUM

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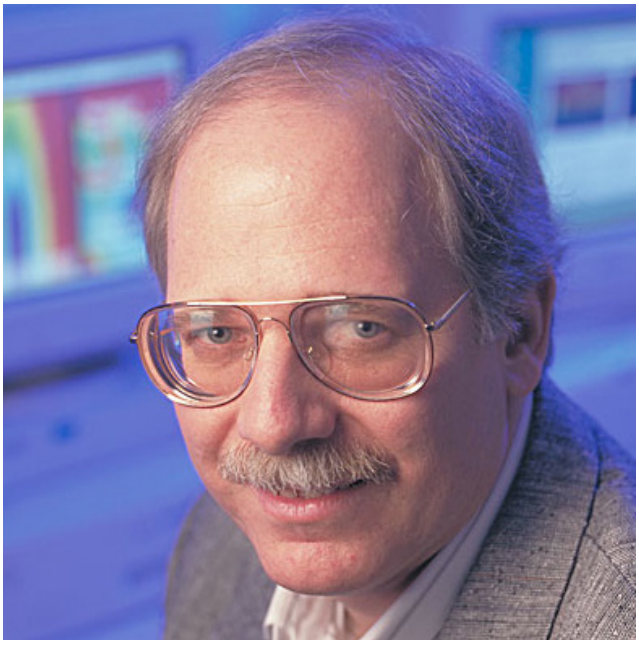
Measuring Everything You've Always Wanted to Know About a Light Pulse



The vast majority of the greatest scientific discoveries of all time have resulted directly from more powerful techniques for measuring light. Indeed, our most im-portant source of information about our universe is light, and our ability to extract information from it is limited only by our ability to measure it.

As a result, we have been developing techniques for measuring, ever more com-pletely, light with ever more complex submicron detail in space and ever more com-plex ultrafast variations in time. The problem is complicated by the fact that laser pulses with variations on such timescales are the shortest events ever created. Worse, measuring an event in time seems to require a shorter one. So the develop-ment of a technique for measuring the shortest events ever created has been partic-ularly difficult: the required shorter event does not exist!

Nevertheless, we have developed simple, elegant methods for fully characterizing these events, that is, for measuring a light pulse's intensity and phase vs. time and space. One involves making an optical spectrogram of the pulse by using nonlinear optical medium. The mathematics involved is equivalent to the two-dimensional phase-retrieval problem—interestingly, a problem that's solvable because the Fun-damental Theorem of Algebra fails for polynomials of two variables. And we have re-cently developed simple methods for measuring the complete spatio-temporal field of an arbitrary light pulse.

THURSDAY, MARCH 21, 2013 | 4:00 PM | HAWKING AUDITORIUM