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Peter Swinnerton-Dyer

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By Sir Peter Swinnerton-Dyer, F.R.S.
Chairman, University Grants Committee

It is an honour to have been invited to open this important conference. Every good physics conference has a few mathematicians hanging around on the outskirts, like scavenger fish, hoping to pick up an interesting problem. They are tolerated because occasionally they do something useful, although most of the time mathematicians modify the problems to make them more elegant or more tractable, and thereby accidentally destroy their relevance to the real world. But it is seldom that such a person is invited into the limelight.

But in fact I am here in quite a different role. Today, when the headlines once again suggest that the Common Market is collapsing under the intolerable burden of the Common Agricultural Policy, it is right to remind you that the E.E.C. serves other and better purposes too. It needs the whole of Europe to provide a market large enough to allow high-technology industry to prosper. Just as national governments do within their own boundaries, the Commission subsidizes across Europe the strategic research from which the next generation of industries will spring. Its latest device for doing so is CODEST, the Committee for the Development of European Science and Technology, which was set up to encourage research across national boundaries. CODEST, of which I am a member, was set up last summer and given a pilot budget of 7 million European currency units for its first two years; if it proves itself successful, it can hope to get very much larger sums in the future. Most of that money will go on small grants, to help cooperative research between pairs of laboratories in different countries; but we were instructed to fund if possible one major project. In two months over the summer, Desmond Smith and Paul Mandel put together just such a project, with collaborators from all across Europe, in a key area of the technology of the future (see table 1). We were not merely happy to fund it, but amazed that such a team could be put together in so short a time. One of the side effects is this conference.

What this conference is about is the technology that will be needed for the computers and control systems of the future. Charles Babbage is always described as the father of the computer. But even if someone had assembled the vast collection of cogwheels, powered by a team of horses, which he designed, the result would not have been a true computer but only a calculating engine. What it lacked was the power to control its own procedures: the ability to do logical operations. In that sense, the first step towards the computer age was taken 80 years ago, when Lee de Forest invented the triode valve. By that device, for the first time, electricity could control itself (see table 2). It is less than 40 years ago that the first stored-program computer worked: EDSAC 1 in Cambridge, which (though wholly electronic) was not all that much smaller than Babbage's monstrous engine would have been. Progress since then has been amazing, but it seems that we are now close to the limits of what electronics can do unaided, and it is time to call in optics as a partner. That that should be possible has only become clear within the last 10 years. First the invention of optically bistable devices, then the implementation of the basic logical operations at what one hopes will become picosecond speeds, have made available the building blocks of an optical computer. Putting them together is still to come; but it is bound to come. I hope this conference will be a substantial step forward towards that goal.

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Table 1. Summary of the European Joint Optical Bistability (E.J.O.B.) Project

(Total funds: 1.8 million European currency units. Period: 1984 and 1985.)

institution		subject area	leaders
Brussels (Université Libre)	theory:	dynamics computer architecture	P. Mandel
Edinburgh (Heriot-Watt University)	theory:	macroscopic device modelling transverse effects	W. J. Firth
		microscopic nonlinearity	B. S. Wherrett
	experiment:	logic gates transphasors optical processor new materials	S. D. Smith
Frankfurt (University of Frankfurt)	theory:	nonlinearity in solids many-body theory	H. Haug
	experiment:	cadmium sulphide	K. Klingshirn
Freiburg (Fraunhofer Institute)	experiment:	infrared diode lasers lead salts	H. Preier
Milan (University of Milan)	theory:	two-dimensional dynamics	L. Lugiato
Munich (Max-Planck-Institute for Quantum Optics)	theory:	device modelling radiation pressure	P. Meystre H. Walther
	experiment:	radiation pressure	
Pisa (University of Pisa)	experiment:	clocks	E. Arimondo
Strasbourg (C.N.R.S.)	experiment:	biexciton processes picosecond speeds new materials	B. Grun, R. Levy B. Honerlage
		subcontracts and associated laboratories	
Florence (University of Florence)	theory:	noise limits	F. T. Arecchi
Dublin (University College) (Trinity College, from October 1984)	theory:	propagation	D. L. Weaire
Berlin (Technical University)	experiment:	silicon	H. Eichler
Royal Signals and Radar Establishment (Malvern)	experiment:	materials	A. Miller

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Table 2. History of the computer age

	electronics
1908	Lee de Forest's triode valve patent
'Electricity controls electricity'	
1908–47	development of vacuum tube electronics
1947	transistor – solid state electronics
1960	integrated solid state circuits
1960–75	digital electronics: computing, *ca.* 1 ns switching, memories
1970s	optical fibres (larger bandwidth for communications) replaced cables by 1983: *opto-electronics*
1975	VLSI – smaller circuits – interconnections controlled by capacitance – 1 nanosecond? – Von Neumann bottleneck
	photonics
1976	first optical bistability observed
1979	first semiconductor bistability in small devices (first 'optical transistor') with gain
'Light controls light'	
1982	optically bistable devices as externally addressed logic gates: AND, OR, NAND, NOR; picosecond switching?
1983	transphasor gain 10^4; incoherent–coherent conversion; one gate switches another

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