LETTERS

Republican Presidential Candidate Presents Views on Science Issues

The Dole–Kemp campaign was not able to accept PHYSICS TODAY's invitation to contribute to the "Special Washington Report" (October, page SR1) in which the principal presidential candidates were given an opportunity to answer questions about critical issues of concern to the physics community. In this letter, therefore, I would like to address some brief remarks on those issues directly to your readers.

America owes a debt of gratitude to the physics community. Your work led to the technologies that won the cold war and brought us the highest standard of living the world has ever known. I have always realized the importance of the physical sciences, and have tried to support you in your search for the truth.

In the Dole administration, we will ensure that all policy decisions are based on good science—in Federal R&D funding, in environmental regulations and in US participation in international research. America needs objective assessments by scientists and engineers who have the intellectual freedom to present the scientific facts. In my administration, we will look to the benefits and costs of various alternatives, and there will be openness and reliance on scientific truth.

If I am elected president, I intend to convene a national meeting of the leaders of the research community to learn how my administration can motivate industry to support strong research laboratories and cooperate with our research universities. The relationships between the Federal and state governments, universities and industry will determine the future of our research enterprise.

We will accelerate the flow of basic research from our universities to American industry. We will take steps to close the gap between initial research, and subsequent development supported by the private sector. This will be accomplished by making changes in our tax codes and regulations to render the government less intrusive. Industrial research depends on companies' return on their investment. Lower taxes, especially capital gains taxes, help companies to achieve that return and to fund research. Similarly, removal of unnecessary regulatory and antitrust barriers will help companies find a clear path to profitability when basic research is successful.

The primary means of government/industry cooperation should be the transfer of technology to industry from federally funded programs. I consistently advocated technology transfer throughout my years in Congress. I sponsored the Bayh–Dole Act of 1980, which set up the technology transfer programs keyed to the research universities.

Defense has always been one of the main areas for physics research, and I have tried to ensure that such research is adequately funded. Throughout the years, I have consistently supported the Strategic Defense Initiative. I introduced the Defend America Act in Congress this year. The bill calls for a national missile defense system by the year 2003 to protect America from foreign missiles. President Clinton signaled that he would veto it; under my administration, the program will go forward.

Much of the federally funded physics work is in energy research. I have supported this work through the years and sought increased funding for basic research among a balanced array of promising energy areas. President Clinton, on the other hand, has advocated reductions in nuclear energy research, highlighting his stand in his first State of the Union address in 1993.

Similarly, in fossil energy, the Federal government should not be discouraging the use of fossil fuels in the way the Clinton Administration has tried to. The science community is aware that global climate change is an area of ongoing research, which is still being explored and debated. Clinton administration officials have attempted to push premature and ex-

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pensive reductions of carbon dioxide while the basic science is still being analyzed. They advocated a BTU tax in 1993, and I was one of the leaders who stopped them. Their proposed tax on fossil fuels did not pass, even in a Congress then controlled by Democrats. As everyone in the physical sciences knows, the science must come first, before we can start making policy.

The Department of Energy, the Department of Commerce and NASA have been doing good science for many years, and I will continue to support their research funding. The funding situation for each program needs to be reviewed on an individual basis despite any changes to the overall agencies. I am committed to reorganizing DOE and Commerce, such that the research money goes to support researchers, rather than for agency overhead. In the Dole administration, there will be better coordination of Federal R&D efforts through the Office of Science and Technology Policy. An across-the-board review of programs should be an ongoing effort throughout the year. There should be an open dialog between Federal agencies, Congress and the scientific community.

We need to work with the physics community to foster a better understanding of science and technology among the general public. Recently, the Federal government has made things worse. For instance, in the Clinton Administration's Goals 2000 program, national history standards were developed that had no mention of Thomas Edison or the Wright brothers. How can we get kids excited about becoming scientists, engineers, or technological entrepreneurs if they are taught a form of history in which role models are removed?

Under the Dole administration, I look forward to working with you in an era where good science will be consistently supported.

ROBERT J. DOLE
Washington, DC

Future of Quantum Computing Proves to Be Debatable

In presenting their opinions in the article "Quantum Computing: Dream or Nightmare?" (August, page 51), Serge Haroche and Jean-Michel Raimond conclude that large-scale quantum computation will remain merely a dream of computer theorists. Their principal argument is that, for a quantum computer to be useful, the ratio R of quantum gate speed to decoherence rate would have to be much higher than what can be obtained in the laboratory. Based on what has been achieved so far, this may be a safe bet. However, the subject is still in its infancy and at this time, its fundamental limits are not understood. Lacking such an understanding, Haroche and Raimond's pessimism about quantum computing is, in our opinion, premature.

To put developments into perspective, it should be recognized that although the field of quantum computation is about 15 years old, algorithms that could provide dramatic speedup over conventional computers (by employing quantum entanglement) were discovered only a couple of years ago,[1,2] and the experiments on quantum logic they stimulated are less than a year old.

Although the application of quantum computers to factoring large numbers[1] seems extremely difficult to implement, it is highly unlikely that no other applications of quantum logic will ever be discovered.[3] In addition, theorists have begun to investigate "quantum error correction" codes only within the last several months, and indications are that the maximum number of gate operations may not necessarily be limited by the value of R. As Peter Shor has informed us, quantum error correction may be able to stabilize the decoherence of entangled states providing that R reaches some threshold value—say between 10^4 and 10^8—regardless of the number of operations. It therefore seems premature to claim that a quantum computer would be useful only if R is of order 10^{11}, or that any application requiring more than 3×10^6 optical operations would be fundamentally disallowed.

Experimentally, our laboratory has demonstrated a "controlled-NOT" quantum logic gate with a single trapped ion,[4] following the ideas of Ignacio Cirac and Peter Zoller.[5] (See PHYSICS TODAY, March, page 21.) In the experiment, R was about 10^1 and the gate time was about 50 s. However, as is often the case in experimental physics, this apparatus was assembled with the least effort necessary to exhibit the desired behavior and should not be taken to represent the technological limit. Although the task of scaling this system to large numbers of ions and gates involving massively entangled quantum states is daunting, the pitfalls are technical, not fundamental.

It is too early to make absolute assertions regarding the viability of quantum computation when such a large degree of uncertainty in both