

Controlling chemical reactions in the quantum regime

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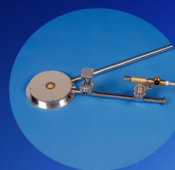
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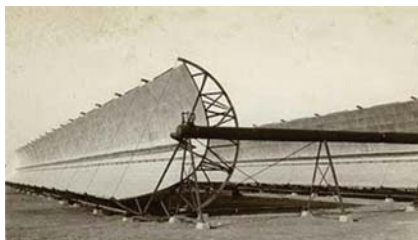
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Frank Shuman's solar collector, built in 1908 in Meadi, Egypt. (Courtesy of Tacony Historical Society.)

quate for the operation of CSP? Can the deserts provide—locally or through importation—the water resources needed to sustain CSP plants without denying desert inhabitants the water they need for survival? To reduce water usage for CSP, we could use dry-cooling instead of wet-cooling towers, but even with dry cooling, will the water resources be sufficient for the total steam cycle and for cleaning mirrors?

Gerhard Knies's hopes for CSP in deserts, like Shuman's a century ago, are admirable. But Knies's prophecy that "the transfer from fossil fuel to renewable energy will become the biggest business of the future" is reminiscent of other grossly inaccurate energy-related predictions. For example, Lewis Strauss claimed more than 50 years ago that atomic power was the answer to energy problems and that it would make "electricity too cheap to meter."⁷⁵ History shows that such claims should be made with considerable caution.

References

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Controlling chemical reactions in the quantum regime

Debbie Jin and Jun Ye, in "Polar molecules in the quantum regime" (PHYSICS TODAY, May 2011, page 27), provide an enlightening overview of their recent work on cold molecular gases; they note a significant opportunity to study and manipulate chemical reactions in a regime in which quantum effects are important. In the case of their potassium–rubidium system, they regard the observed reaction



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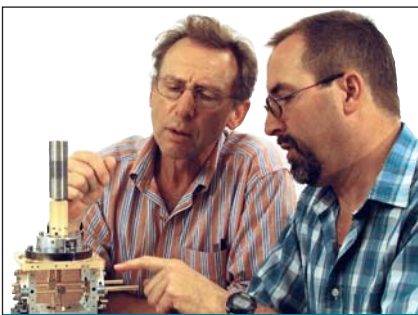
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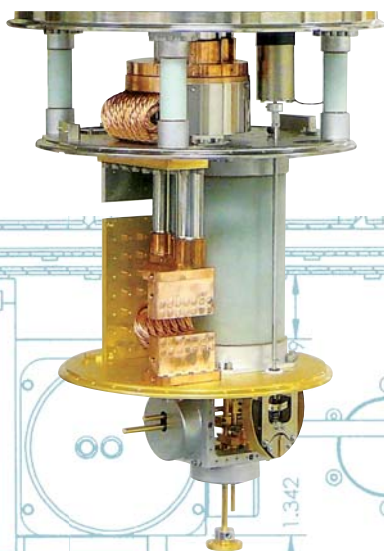
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$\text{KRb} + \text{KRb} \rightarrow \text{K}_2 + \text{Rb}_2$ as being of great interest but also as being a significant impediment to the goal of preparing a quantum gas of oriented KRb molecules.

The cold gas that Jin and Ye have created does indeed offer a unique environment to study chemical reactions that are strongly affected by quantum mechanics. One such opportunity, not noted in their article, is the ability to manipulate reaction cross sections by "coherent control."¹ In that approach one creates an initial superposition of scattering states that allows control over reaction cross sections through quantum interference.

Two coherent control scenarios are worth examining toward the goal of controlling or reducing the $\text{KRb} + \text{KRb}$ reactive cross section. The first was designed to control cross sections in the scattering of identical diatomic molecules, and the second is a method capable of suppressing reactive scattering by suitable preparation of the initial scattering state. Both are discussed in reference 1.

Demonstrating coherent control of collisional processes in the cold KRb gas would contribute greatly to understanding and manipulating chemical reactions on a fundamental quantum level. The use of such control to suppress the $\text{KRb} + \text{KRb}$ reaction, if successful, would be an added technological benefit on the way to producing the desired quantum gas of oriented molecules.

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The myth of Earth's stable axis

Johanna Miller's otherwise excellent article on the Martian icecap (PHYSICS TODAY, June 2011, page 12) was slightly marred by the opening paragraph, which repeated the myth that Earth, unlike Mars, has a stable axis because of our large moon. I'm afraid things are not that simple. The Moon does indeed have a stabilizing influence since its presence increases Earth's pre-

cession rate thus avoiding chaotic resonant interactions with the rest of the solar system.¹ However, increased tidal drag resulting from the Moon's presence slows our rotation; that slowing in turn reduces Earth's equatorial bulge and leads to slower precession and, eventually, to an unstable axis.² Long-term axial stability is best achieved by rapid spin (to give a large equatorial bulge) and no moon (to reduce tidal drag).

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Corrections

September 2011, page 72—Harry Lustig's article, "The life and times of Werner Heisenberg," was published in the journal *Physics in Perspective*.

October 2011, page 22—The image below is the correct artist's conception of Sierra Nevada Corp's proposed



Dream Chaser craft, which would transport crew to and from the International Space Station. ■

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