panel A in the figure), in which oxygens and platinum atoms are three- and fourfold coordinated and build a 3,4-connected net (panel B). The decoration replaces Pt by squares and O by triangles and generates the topology of panel C. Squares and triangles may be referred to as the topological SBU; that is, they represent species whose connectivity is four for the squares and three for the triangles, whatever their chemical nature.

In Chen *et al.*'s macroporous material, the squares are taken up by a binuclear Cu carboxylate moiety, and the triangle is formed by 4,4′,4″-benzene-1,3,5-triyl-tribenzoic acid, with three corners of the benzene ring acting as the vertices of the inner triangle, the linkers being phenyl groups. The risk of interpenetration is lowered because the π–π interactions between the benzyl groups render the two equal sublattices interwoven instead of interpenetrating. This creates accessible pores with a free diameter of about 16 Å and windows with dimensions of 7 Å by 14 Å (corresponding to a surface area of 1500 m^2/g) after elimination of the solvents that reside in the cavities.

These properties are remarkable but are not as important as the new strategy described here. In this strategy, specific chemistry is only introduced after having chosen a desired topology and the tectons that may enable it to be formed. Moreover, the approach is general because it is independent of the nature of the reactants. It only depends on the connectivity of the tectons and thus allows every modulation of the chemical nature of topological SBUs, and every modulation of the linkers, within a given topology. The composition of a given solid is also known before synthesis because the ratio between the different topological SBUs is fixed by the choice of the initial structure type. With the success of such a strategy, the synthesis of porous solids will never be like it was before.

A final question arises. Many new solids have been reported recently that are crystalline and have giant pores, but what is the limit? Can we achieve crystalline materials with pores of the same size as in the so-called mesoporous solids (which have amorphous or disordered walls)? Progress can be expected to be rapid at this frontier between micro- and mesoporous solids, and new materials may soon exist that we cannot even imagine yet. The strategy demonstrated by Chen *et al.* is likely to play an important role in shaping this porous future.

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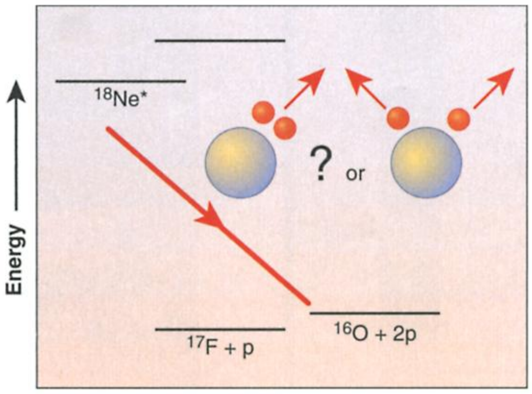
PERSPECTIVES: RADIOACTIVITY

Are Protons Leaving in Pairs?

Phil Woods

Nuclear physicists exploring the extreme limits of nuclear stability are discovering exotic phenomena not manifest in relatively stable nuclei. For example, a substantial number of neutron-deficient isotopes decay from their ground states through the emission of a single proton (*1*). Such proton radioactivity is, however, only observed for nuclei with an odd proton number, *Z*. In nuclei with even *Z*, the protons pair up, resulting in enhanced nuclear binding. As a result, single-proton emission becomes energetically forbidden or highly suppressed. But it turns out that an even more exotic decay pathway may be available in these cases.

Already in 1960, the Russian nuclear theoretician Vitaly Goldansky predicted (*2*) that nuclei with an even number of protons could decay from their ground states by the simultaneous emission of two protons. Since then, great efforts have been made to explore this exotic ground-state decay mode. Nuclear physicists have also searched for simultaneous two-proton emission from excited quantum states in nuclei. Simultaneous two-proton emission from an excited nuclear state was recently



Unusual decay. The excited ^{18}Ne nucleus can only emit two protons simultaneously because there are no allowed pathways to the intermediate system, ^{17}F. It is not yet known, however, whether the two protons are emitted as a ^{2}He cluster or democratically (see text).

reported in *Physical Review Letters* (*3*). Tantalizingly, the two extreme theoretical descriptions of the decay process describe the present data equally well.

When Goldansky published his prediction, it was already known that the ground state of ^{6}Be was unstable to decay into two protons and an α particle (a $^{4}He^{2+}$ particle). However, the ^{6}Be isotope only existed as a short-lived state, the formation of which had to be inferred by observing its proton and α-decay products. This indirect evidence was not enough to nail the decay mechanism. In 1989, a group at the Kurchatov Institute in Moscow performed experiments that allowed the energy and angular distributions of the ^{6}Be decay products to be studied in great detail (*4*). On the basis of these studies, the group introduced the term "democratic decay" into the nuclear lexicon. It symbolizes the simultaneous breakup of a nucleus into three particles without passing through an intermediate stage. The authors demonstrated that the ^{6}Be decay process could be understood in terms of three basic competing patterns of decay: the "cigar mode," in which the protons are emitted from opposite sides of the α particle (spatial anticorrelation); the "di-proton decay mode," in which the protons are emitted in the same direction and are spatially correlated to the extent that the protons can be considered to exist as a metastable ^{2}He cluster; and the "helicopter mode," in which the protons are emitted with their spins aligned—a phenomenon that is not allowed by the proton-proton pair interactions but can occur prolifically because of the third body (the α particle). More recently, two-proton emission has been detected in the ground state decay of ^{12}O, which like ^{6}Be has too short a half-life to be observed directly (*5*). In this case, the protons were found to be emitted isotropically, but a sequential decay mechanism could not be ruled out and the exact

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nature of the decay mechanism remains a matter of debate in the literature (*6*). This represents the sum total of our current knowledge of ground state two-proton decay processes.

In 2000, experiments at the GANIL laboratory in France directly detected the existence of the highly exotic isotope ^{48}Ni (*7*). This isotope is thought to be a prime candidate for two-proton radioactivity because its ground state is predicted to be energetically unbound to the simultaneous emission of two protons, but bound to the emission of a single proton. Calculations generally assume a binary model of ^{48}Ni consisting of an inert nuclear core and two outer protons that form a pointlike ^{2}He cluster. According to this model, the ^{2}He cluster quantum tunnels through a potential energy barrier and then decays into two protons outside the barrier. However, theoretical objections have recently been raised to this simple approach (*8*). A more sophisticated theoretical approach based on an explicit three-body democratic decay model of the simultaneous two-proton emission process suggests that the probability of two-proton emission is reduced substantially compared with the pure ^{2}He emission calculations (*8*), in which case ^{48}Ni may decay by β-emission instead. It should be noted that this more sophisticated theoretical approach allows for a ^{2}He component in the decay process because it is one possible scenario for nonsequential two-proton emission.

Given the paucity of information on the ground state two-proton decay mechanism, nuclear physicists have sought to study excited states of nuclei that are two-proton unbound. Unfortunately, in all cases studied to date, these states have preferred to decay by the sequential emission of protons. For example, in work at the Louvain-la-Neuve Laboratory in Belgium, a radioactive ^{13}N beam was used to bombard H atoms and thereby populate an excited state of ^{14}O. A two-proton emission decay branch was identified, but a path for decay by sequential emission was also available and this is what the nuclei overwhelmingly decided to do (*9*).

Physicists at the Oak Ridge National Laboratory have been developing a ^{17}F radioactive beam. They recently used this beam to bombard H atoms to produce two-proton unbound excited states in the fused compound nucleus ^{18}Ne (*10*). These excited states cannot decay sequentially because there are no allowed paths in the appropriate energy region for this process to occur. The observation of a two-proton decay branch in this system would therefore have to be attributed to simultaneous two-proton emission.

This year, the Oak Ridge Group reported the observation of such a simultaneous two-proton decay branch (*3*) from one of the excited states in ^{18}Ne. Monte Carlo simulations of the energy and angular distributions of the two protons are consistent with either the binary model described above or a three-body democratic decay process.

Is this state democratic or tyrannical (that is, dominated by ^{2}He emission)? The researchers at Oak Ridge plan to resolve this mystery by using a larger detection system. A pure ^{2}He decay component would be a major surprise and would be indicative of a larger than expected ^{2}He cluster component in the nuclear wave function. If this is the case, then one needs to ask whether this could be observed in many other two-proton unbound nuclear states, and if not, what is so special about ^{18}Ne?

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10. When two nuclei collide, they initially fuse to form a single composite system known as the compound nucleus, which subsequently de-excites, in this case by the emission of two protons.

PERSPECTIVES: ECOLOGY AND EVOLUTION

The Risk of Extinction—What You Don't Know Will Hurt You

John L. Gittleman and Matthew E. Gompper

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Ecological circumstances, such as living on an island or in a pristine habitat, often lead to an unusually high level of predation among prey populations when predators are reintroduced. For example, Darwin was able to collect a specimen of the now extinct Falkland Island wolf simply by walking up to one and killing it. Indeed, 81% of known mammalian extinctions during the last 500 years have been among mammals endemic to island habitats (*1*). The most powerful illustration of how naïveté to danger may lead to elimination comes from the extinctions of the late Quaternary, during which more than half of the 167 genera of large land mammals (>44 kg) became extinct, primarily because of the rapid and catastrophic effects of "first contact" with colonizing human hunters (*2*). Currently, many of the world's large terrestrial carnivores are threatened with extinction. But conservation efforts to reintroduce carnivores to their original habitats have met with concern because of the possible drastic reduction in naïve prey populations. An elegant study by Berger and colleagues (*3*) on page 1036 of this issue investigates whether ignorance of danger (naïveté) should be added to the "Evil Quartet" of extinction causes—habitat destruction, overexploitation, introduced species, and secondary extinctions (*4*).

With the local extirpation of increasing numbers of carnivore species, recolonization and reintroduction efforts are commonplace. Many species are even being introduced into areas where they did not previously roam. For predatory carnivores, such as grizzly bear and wolf, a very conservative estimate is that there have been 173 independent introductions worldwide, about 19% recorded on continents, 18% on continental shelf islands, and 63% on islands (*5*). Given the fragility of island populations, this does not bode well for long-term ecological success. More appropriate to the goals of conservation are reintroduction programs in which species are reestablished in their historical range. But even these projects have their problems. First, of the 165 carnivore reintroduction programs carried out so far (*6*), only 28 involve threatened species (see the figure). Second, according to the published opinions of those working on these projects, 70 of the 165 (42%) have been successful, 44 (27%) have failed, 12 (7%) still have uncertain outcomes, 15 (9%) are in the release phase, and 24 (15%) have not been evaluated. Last, and most relevant here, none of the carnivore reintroduction projects have assessed how prey populations respond to the reintroduction of predator species. The effects of worldwide carnivore expansion

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