drothermal vents, rust tubes emanating from corroded iron or steel, and hollow, briny icicles under Arctic sea ice.

De Wit and her colleagues see another compelling application for their approach: building new complex materials. By turning to a catalog of patterns or phases like the one in figure 1, researchers may be able, De Wit speculates, to control the reaction well enough to produce the desired pattern and complexity. But that's a goal for the long run. And it may involve other building blocks. A related class of self-assembling mineral aggregates known as silica biomorphs also exploits steep pH gradients like those found in chemical gardens—though using a different mechanism—to assemble leaf-like sheets, helical filaments, and "cauliflowers" (see PHYSICS TODAY, March 2009, page 17).[3]

Possibilities abound. It's intriguing to imagine, for instance, a filament-rich chemical garden, tailor-made using an appropriately tweaked recipe, operating as a microfluidic delivery system or catalytic filter.

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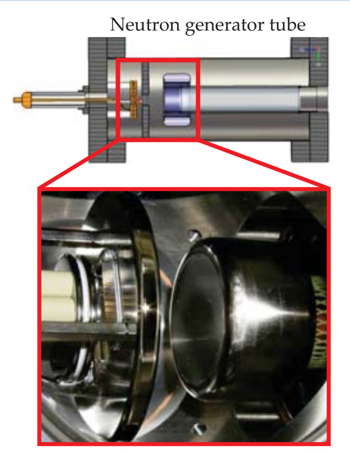
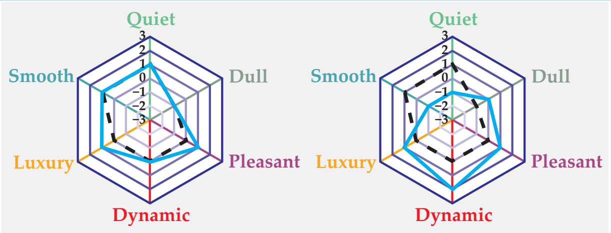
3. See also W. L. Noorduin et al., *Science* **340**, 832 (2013).



pact 10- to 20-kV power supply; the concentrated field rips apart and ionizes the molecular deuterium gas near the tips. Impinging on a tritiated-titanium target (at right) that is biased to −100 kV, a pulsed D^+ current of 120 nA in the prototype generates bursts of 10^7 14-MeV neutrons, a flux that is an order of magnitude higher than was previously available in field-ionization neutron sources. The team's prototype has produced D^+ currents up to 500 nA while consuming less than 10 W. The LLNL team is bringing the size and weight down and the output up, which will allow neutron analysis to join portable x-ray devices in the field of nondestructive materials interrogation. (J. Ellsworth et al., *J. Appl. Phys.* **116**, 193301, 2014.) —SGB

Sound design for electric vehicles. The interior of an electric vehicle can sound eerily quiet without the noise of a combustion engine, yet also annoying due to unfamiliar, high-frequency sound components. Options for introducing virtual sounds are boundless, but as Soogab Lee and colleagues at Seoul National University show, psychoacoustics and musical harmonic theory can offer guidance. Both loudness and sharpness, which is related to the proportion of high-frequency components, can negatively affect pleasantness. To enhance the dynamic impression, the researchers wanted the sounds to correlate with speed. Harmonious



engine sounds, whose frequencies are in simple integer ratios, have been found to be more pleasant, so the Seoul team focused on tones harmonically related to the car interior's dominant high-frequency component during acceleration. The researchers had 27 volunteers evaluate five combinations of added tones (available online) by rating their overall impression and then describing the sounds in terms of attribute pairs "pleasant–unpleasant," "calm–dynamic," "smooth–rough," "loud–quiet," "sharp–dull," and "luxury–cheap." As shown by the figure's blue lines, two of the five were rated higher for luxury and pleasantness than the base sound (dashed line) and were more preferred overall. For the combination rated on the left (the fourth audio sample), the original and added tones had the frequency ratio 5:3:1, reminiscent of a clarinet. The other (the third sample), with subharmonics that were three and four octaves below the original, was deemed rougher and louder but more dynamic. That combination was particularly favored by the dozen testers who like their cars "sporty." (D. Y. Gwak et al., *J. Acoust. Soc. Am.* **136**, EL391, 2014.) —RJF

Extragalactic Rydberg atoms. The cold neutral medium (CNM) is one of the most enigmatic components of interstellar space. Conditions that prevail in the low-temperature, low-density CNM are such that carbon atoms are more likely to be ionized than the more abundant hydrogen atoms. And when those atoms recombine with ambient electrons, they can form fragile, high-quantum-number Rydberg states whose initial deexcitations entail the emission of low-energy photons. Photons from those deexcitations have now been seen outside our galaxy for the first time. Leah Morabito of Leiden University in the Netherlands and her collaborators found them in the nearby star-forming galaxy M82; they used LOFAR, an array of about 20 000 radio dipole antennas centered in a field outside the Dutch village of Exloo. LOFAR can barely detect individual Rydberg transitions in M82. But by stacking the spectra of 22 transitions from quantum numbers 468–508 down to the next lowest state, Morabito and her colleagues obtained an 8.5-standard-deviation detection. For this proof-of-concept observation, only LOFAR's central 2-km core was used (see figure).

Although the core couldn't resolve M82's structure, the stacked spectrum's profile suggests that the origin of the carbon absorption lies in the vicinity of the galaxy's star-forming nucleus. Future observations with the full array will pinpoint the carbon's location. The discovery of extragalactic Rydberg absorption opens a new window on the CNM, which LOFAR's more sensitive successor, the Square Kilometer Array, is poised to exploit when it debuts next decade. (L. K. Morabito et al., *Astrophys. J. Lett.* **795**, L33, 2014.) —CD ■