physics undergraduate publications; helped revive Hunter College's physics and astronomy club and served as its vice president; served on AMNH's Youth and Alumni Committee, where I helped run student events and promoted education programs; and organized a coding "hack day" for CUNY women in STEM. The "soft" skills that I developed in those nonresearch pursuits served me well in giving presentations, participating in discipline-specific workshops, and collaborating with scientists.

During my last year as an undergraduate, I applied to PhD programs in astronomy and astrophysics and for postbaccalaureate positions. In my application, I highlighted the multiple ways in which I had participated in science throughout my college years. I came to appreciate the early and long-standing investment that my mentors at BDNYC, AstroCom NYC, and the University of Michigan had made in me as they supported my research and allowed me time and freedom to identify and follow my own path. Because of those experiences I can envision making a contribution to the field, and I see it arising from my passion for education, communication, and collaboration and from my varied experience. I consider myself fortunate that admissions committees seem to have seen value in the skills I gained outside the lab.

The days of scientists all having the same personal and professional background are slowly coming to an end. My story here may be a bit uncommon, but I don't think it should be. Varied internship experiences have shaped my idea of physics as a field into that of one I can see myself working in long term. They have also helped me gain skills that will ultimately form my contributions to the field, and those skills are not mathematical genius or the ability to answer a hundred physics questions in three hours. I have gone from planning to be a high school physics teacher to receiving a Fulbright grant for 2018–19 to study the lowest mass stars at the Leibniz Institute for Astrophysics Potsdam in Germany. And now I have plans to enroll this fall in Harvard University's astronomy department to pursue a PhD.

Especially for students who do not fit the scientist stereotype, having the opportunities and time to explore a field and find their place in it is essential. The scientific community would do well to make various opportunities accessible to students with different socioeconomic, racial, and educational backgrounds; gender identities; sexual orientations; and physical abilities. Science directly benefits from a diverse set of thinkers with diverse skills.

Victoria DiTomasso
(victoriaditomasso@gmail.com)
Potsdam, Germany

LETTERS

Challenges facing high-field tokamaks

David Kramer wrote an interesting report on high-magnetic-field fusion devices for the August 2018 issue of Physics Today (page 25). The high magnetic field certainly does shrink the device's plasma volume, but high magnetic field is a double-edged sword. It has significant disadvantages. The story points out only one: the increased pressure on the field coils.

Another disadvantage is that as one shrinks the device, the neutron wall loading increases. Take SPARC, the tokamak being developed by Commonwealth Fusion Systems (CFS). It has 1/70 the volume of ITER, the international prototype fusion energy reactor, but 10 times the power density. Whereas ITER hopes to achieve 500 MW of neutron power, SPARC hopes to achieve about 70 MW. If one assumes surface area scales as the 2/3 power of volume, SPARC's surface area is about 1/17 of ITER's. Hence SPARC, a small experimental device, will have about 2.5 times ITER's wall loading of about 1 MW/m^2! The problem will only get worse as CFS moves to devices like the ARC (affordable, robust, compact) reactor, which will produce commercially interesting amounts of power. Wall loading is a big issue, not a minor detail, in fusion physics.

In addition, whereas the plasma scales to smaller size with increasing magnetic field, the fusion blanket does not. No matter what the magnetic field, the blanket has to prevent leakage of uncharged neutrons out the other end. The minimum blanket thickness I have seen is about one and a half meters thick. The blanket alone dictates some minimum size for a power-producing fusion device. It is difficult to see how shrinking the minor radius to below a meter buys you very much if the blanket thickness is one and a half meters. That could be a problem especially for the Tokamak Energy device, a spherical tokamak, which relies on a thin center post that must remain superconducting in the presence of an intense neutron flux.

To me, the most important advantage of using high-temperature superconductors (HTS), whether at 5 T or 10 T, is a point Kramer mentions in passing at the end. Namely, the magnets could be disassembled and reassembled rather easily. Since I first heard of tokamaks a half century ago, the story has always been that because of the interlocking coil arrangement, one could not do maintenance on them. The new HTS magnets, in one fell swoop, may have solved that issue. To me, that is the really big deal.

Wallace Manheimer
(wallymanheimer@yahoo.com)
Allendale, New Jersey PT