the last fall-semester meeting of Ed Purcell's course for concentrators in physics. I taught it while Ed was on sabbatical and, appropriately, sang the role of Professor. The counterpoint was sung by Tom, David Robinson, Bob Welker, and Munroe Edmunson as the students. I told the students this would be a preparatory session for the final exam. The song whose lyrics appeared in the PHYSICS TODAY spread was the opening number. The final piece was more faithful to my description of the class that day. It was sung to the music of a scatological Mozart canon, "Oh, du Eselhafter Martin."

Professor
Now, then, are there any questions?
Any problems, any questions?
If there are none, then I am done.
And I can bid you all good day. . . .
Just one more thing, and do not
laugh;
I hope you take the second half.
Physics, Physics, Physics 11b.

Students
Ha, he asks if there are questions.
Holy smoke have I got questions!
I've got a ton, and every one
Would take him half a day to do.
But I don't really want to stay here,
since he's said all he has to
say here.
But it's agreed that I shall need
much more than luck on the
examination. . . .
One thing that makes me laugh:
He hopes I'll take the second half.
Ha ha, ha ha, ha ha, don't make
me laugh.

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As an educator whose motivation and outreach repertoire includes writing and performing songs (see http://www.math.utep.edu/Faculty/lesser/Mathemusician.html), I enjoyed July's "Physics Songbag." Although the examples were inherently enjoyable, readers may not have realized just how widespread and serious such songwriting is.

Educational songs are gaining attention and support. Examples include the *Physics Pholk Songs* CD, partially funded by NSF and available for purchase at http://www.teachersource.com/catalog/index.html, the searchable science song database http://www.science-groove.org/MASSIVE/, and an article in the *Wall Street Journal*.[1]

Using songs in the classroom is fun and community-building, but also has research-backed benefits in helping to motivate students and helping them to recall information. See, for instance, http://www.science-groove.org/SSA/pedagogy.html and http://www.songsforteaching.com/references.htm.

Although many writers of educational songs take their craft quite seriously—there is the Science Songwriters Association—and have released professional recordings, songwriting is too fun and valuable to leave only to "experts." All teachers and students have the ability and should have the opportunity to enhance class learning with a song, jingle, or rap. Comprehensive articles have been written about the use of songs in teaching math and science.[2,3]

References

1. C. Conkey, *Wall Street Journal*, 27 March 2005, p. B1.
2. L. Lesser, *Math. Teach.* **93**, 5 (2000).
3. L. Lesser, *Teaching Statistics* **23**, 3 (2001).

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The whimsical collection of physics songs in the July issue was fun, but it didn't mention astronomy-related music such as Gustav Holst's instrumental "Mars, the Bringer of War." What is more interesting, it didn't mention attempts by modern professional musicians to incorporate scientific themes.

As a fan of rock and heavy metal, not a genre normally associated with physicists and astronomers, I'll throw out a few examples. "High Speed Dirt" by Megadeth imagines what it might be like to be a meteor flashing across the sky and crashing into the Earth—although the singer may also be crashing from something else. Rush was a popular band for many of us undergraduates in the 1980s, as they explored philosophical and scientific themes to go with their technically fantastic music. "Countdown" relays the emotions felt by the band members as they watched a space shuttle launch, with clips of dialog from mission control and the astronauts aboard.

But the best astronomy-related song of all might be Rush's "Cygnus X-1," released soon after the announcement of the object's discovery in the 1970s. A former quasar astronomer, I still use the piece on my exams for stellar astronomy classes because it correctly depicts a black

hole. For those who are into old album rock, this is a song worth listening to.

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Sakharov Is Tokamak's Originator

The idea for the tokamak, a thermonuclear reactor whose construction is based on the toroidal magnetic confinement of a high-temperature fusion plasma, was first proposed in 1950 by Andrei Sakharov, my late husband. In collaboration with Igor Tamm, Sakharov wrote the first papers on the tokamak. The papers were classified until 1956, when Igor Kurchatov reported them at a conference in Harwell, UK, and were subsequently published in the *Proceedings of the Second International Conference on the Peaceful Uses of Atomic Energy* (Pergamon Press, 1961). This was the beginning of the worldwide work on controlled thermonuclear reaction. Because Sakharov and Tamm were working full-time on the development of a fusion bomb, Lev Artsimovich and Mikhail Leontovich were put in charge of work on the construction of a practical thermonuclear reactor in the USSR. Since Leontovich's death in 1981, Evgenii Velikhov, who succeeded him, has been mistakenly perceived as the originator of the tokamak.

In the USSR, Sakharov's role was initially concealed due to the highly secret nature of his work on nuclear weapons, and then due to his ousting from the Soviet elite in 1968 when he took a public stand on human rights and other political issues. Now there is no reason to conceal his being the originator. In chapter 9 of his *Memoirs* (Alfred Knopf, 1990), Sakharov describes in some detail the early Soviet work on a thermonuclear reactor.

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Lessons Learned from the World Year of Physics

I have learned or understood more physics this year by way of the excellent articles, letters, and discussion in PHYSICS TODAY than in my entire undergraduate education. In particular, the articles and discussion on fundamental physics related to Einstein's legacy have been scientifically and historically stimulating. Each month I look forward to reading the magazine, and I hope its quantum leap in educational value will shine on in subsequent issues after the World Year of Physics 2005 and the many celebrations of it.

Now what shall we do about undergraduate education? Perhaps compulsory reading and discussion of PHYSICS TODAY is in order, starting from January 2005!

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Sorting Out the Potts Models

It was a great pleasure to hear that the American Physical Society had awarded me the 2006 Lars Onsager

See www.pt.ims.ca/6089-10