FROM THE EDITOR

Declare your motivations

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For Physics Today's November 2002 issue (page 22), I wrote a news story entitled "Why do lobsters change color when cooked?" The unlikely topic readily qualified for coverage. Obtaining the answer to the title's question entailed using three innovative crystallographic techniques. Astaxanthin, the pigment responsible for the color of the lobster's exoskeleton, is biophysically interesting and biomedically significant.

Still, my fellow editors and I determined that the story should be short. Accordingly, I left out much of what I'd learned from my interviewees about why anyone would want to know how lobsters change from greenish black to orangey red when boiled or broiled.

The story begins with George Wald (1906–97), who was awarded a share of the 1967 Nobel Prize in Physiology or Medicine for identifying the molecules that underlie mammalian vision, a protein called opsin wrapped around a light-absorbing form of vitamin A called retinal. Rhodopsins, as the combinations of opsin and retinal are known, span the membranes of photoreceptor cells, which means their tops and bottoms penetrate the cells' aqueous interior and exterior while their middles abut the membranes' oily interior. Being both hydrophilic and hydrophobic makes opsins and other membrane proteins hard to crystallize. Unable to make crystals of opsin, Wald turned instead to crustacyanin, the pigment in lobster shell.

In my news story I mentioned Wald's interest in crustacyanin, but not his motivation. Although crustacyanin resembles rhodopsin in that it consists of a protein wrapper and astaxanthin, a vitamin-A-like molecule, it is not a membrane protein. Wald hoped to gain insights into the structure of rhodopsin by studying crustacyanin. Perhaps because crustacyanin is surrounded by calcium carbonate, it, too, defied crystallization. Naomi Chayen, who was part of the team that solved the lobster color-change problem, eventually succeeded. Her technique involved topping a solution of crustacyanin with a layer of kerosene thin enough to allow the crustacyanin solution to slowly concentrate via evaporation and crystallize. The crystallization took four months.

Chayen's research is directed at coaxing recalcitrant molecules to crystallize. Her motivation was self-evident. By contrast, the motivations of the paper's lead author, Michele Cianci, surprised me. Crustacyanin is stable in water. It could form the basis of a new class of biocompatible blue food colorants, he told me. Astaxanthin is a potent antioxidant, but the molecule's symmetry deprives it of polarity and therefore the ability to dissolve in water. Wrap a drug like astaxanthin in a protein cage like crustacyanin's, and you could have a way to deliver it through the bloodstream to where it might be needed.

I've just reread the original paper[1] that Cianci, Chayen, and their collaborators published in 2002. It contained even less about their motivations than my short news story did. For comparison, I looked up my own research papers. All of them have coauthors. I picked one that I could remember writing mostly by myself (my coauthor, Christine Done, and I contributed equally to the research).[2] The paper was about x-ray bursters, the neutron star analogs of classical novae that Koji Mukai and Jennifer Sokoloski review in their feature article on page 38.

Material from the neutron star's companion, a low-mass star, makes its way through an accretion disk to the neutron star surface. When enough material has accumulated, it undergoes a thermonuclear detonation, which x-ray detectors record as a sudden and fleeting burst of x rays. My idea was that some of the x rays from the peak of the burst would reflect off the accretion disk and into an observer's line of sight. Spectral features imprinted on the reflected radiation would be challenging to detect given the strong contrast with the direct radiation. But, I hypothesized, the burst's precipitous drop in intensity and the finite speed of light would together ensure that the reflected light from the peak would arrive at a detector at the same time as direct light from the now dimmer burst. Done and I simulated that process to see if absorption lines could be detected.

Alas, I didn't say much about why detecting the lines was interesting or important. Yes, I wrote that it could help discriminate between two emission mechanisms. But why was that interesting or important? I realize now that I had presumed readers would already agree with me that the behavior of plasma under extreme gravity is worth investigating.

If you write papers, please consider declaring your motivations. Your readers will be grateful and interested, even if your motivation is pure curiosity. You'll also earn the gratitude of science journalists at Physics Today and elsewhere who read your papers.

References

1. M. Cianci et al., *Proc. Natl. Acad. Sci. USA* **99**, 9795 (2002).
2. C. S. R. Day, C. Done, *Mon. Not. R. Astron. Soc.* **253**, 35P (1991). PT