the ozone levels in Antarctica have a minimum between September and November. According to Mark Schoeberl, head of the atmospheric chemistry and dynamics branch at the Goddard Space Flight Center, this minimum is a natural phenomenon arising from the normal circulation in the lower stratosphere. But when atmospheric scientists talk about the "ozone hole" today, they refer to the depletion *after* this normal variation has been taken into account. Schoeberl stresses that "the ozone hole is a real and recent physical phenomenon; the data are unambiguous."

Norman S. Benes's reference 1 shows data taken with a Dobson spectrophotometer before 1948 at Arosa, Switzerland, and at Tromsø, Norway, which is above the Arctic circle. The Tromsø data suggest an especially strong seasonal variation of ozone level, which the author of the report terms an "ozone gap." However, Schoeberl tells us that the Dobson data taken during winter by twilight or moonlight—precisely the points that show the greatest deviation—are usually quite unreliable. Satellites measuring the total amount of ozone in a vertical column of the atmosphere have not detected an ozone hole over the Northern Hemisphere to date.

Benes's reference 2 reprints material written in 1968 by G. M. B. Dobson, who remarks on the differences in the ozone amounts in the Northern and Southern Hemispheres at equivalent times of year. According to Schoeberl, these are normal climatological differences caused by the different stratospheric circulation systems in the two hemispheres.

Champagne vs Beer: Comparative Fizzics

Gianni Astarita (July 1992, page 91) does well to bring a familiar fact to the attention of his engineering students to illustrate transport phenomena. But his example, the difference in the foam stabilities of champagne and beer, though striking, is not pertinent, and his explanation, though ingenious, is not correct.

First, the Marangoni stabilizing mechanism, while applicable to ephemeral foams such as those of champagne, is not by itself sufficient to stabilize longer-lived foams such as those of beer, whipped cream or shaving cream. The Marangoni effect is the movement of a liquid surface under the influence of a surface-tension gradient: The movement is from the lower- to the higher-surface-tension regions. In foam films the surface-tension gradient arises from the drainage of the liquid, which is pulled both by gravity and by Laplacian pressure differences created by the curvature of the surface at the Plateau borders. As the liquid film drains, the surface drains with it, thereby reducing the concentration of adsorbed solute in the thinnest portion of the film, causing its surface tension to rise. The Marangoni effect then operates to pull the surface back (and, by viscous drag, a considerable thickness of underlying liquid as well) to restore the thickness of the rapidly diminishing foam film. But this mechanism operates for a short time only, a matter of rather less than a minute, before the foam has drained to a state of dryness that cannot provide enough of the underlying liquid to sustain the stabilizing action.

The stability of beer foam results from another mechanism, namely, the retarding of drainage by the plasticity of the foam film. That plasticity, in turn, is caused by molecules of a solute, such as a protein, that are adsorbed at the surface and bonded there into thick coherent layers by Lewis acid–Lewis base interactions. The Marangoni effect may initiate the stability of bubbles, but the stability is enhanced to a prolonged life by the plasticity conferred on the liquid surfaces. To act in this way, the solute has to be something much more surface active than carbon dioxide, which has only a minor effect on the surface tension of water at the pressures we are considering. Even in champagne, the carbon dioxide is not likely to be the solute responsible for the reduced surface tension and for the stability of the bubbles, transient though they are.

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9/92

ASTARITA REPLIES: I would like to thank Sydney Ross for providing me with an opportunity to make myself very popular with some graduate students. In the interest of science, I bought all of them a round of beer and asked them to estimate experimentally the order of magnitude of the drainage time of the foam. The estimates ranged between 20 seconds and 2 minutes: not very far from the upper limit that Ross assigns for the significance of the Marangoni effect. So perhaps protein adsorption at the interface and the consequent plasticity of the foam film are important in

the final stages of collapse of the beer foam, but my example retains some pertinence and my explanation some degree of correctness, at least for the time scale over which graduate students are willing to put off drinking the beer so as to observe the behavior of its foam. Whipped cream would present analogous experimental problems, and shaving cream would be sexist by virtue of excluding or at least putting into a difficult position all female graduate students; so I have not pursued this experimental program any further.

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4/93

Science Isn't for Some: A Cultural Canard?

Although we have both been readers of PHYSICS TODAY for many years, we have never felt compelled to respond to a letter until reading Joseph Ciparick's letter in the June 1992 issue (page 108). Both of us found the tone and implications of Ciparick's letter to be distressing and to warrant a response.

To suggest that women and minorities have other things to do or "other concerns," so that physics is of less interest to them than it is to others, is reasoning that is dangerously close to the kind that perpetuates such thoroughly discredited canards as "women should be nurses, but men should be doctors" or that certain racial types are destined by their physiology to be athletes. In addition, to suggest that a teacher correlate a student's degree of interest in physics, or any science for that matter, with the desire that it be a career goes completely against the philosophy of a liberal arts education. Interest in any discipline must be cultivated in spite of a student's career choice, not because of it. As soon as a high school or college teacher singles out the prospective professionals in his or her classroom as those with real interest, who thus deserve attention, that person ceases being a teacher and becomes a proselytizer or indoctrinator. The most genuine form of student interest at that level should originate in the desire to know and understand, not the desire to have a successful career.

Not only does Ciparick provide us with explanations for a lack of interest in physics by women and minorities; he also has a theory that covers the indifference of religious "true believers." Far from religious belief's being antithetical to scientific belief, we suspect the opposite is true. The mind wants to believe in some principle of order and coherence. The same inner drive that makes us seek out religion to answer certain types of questions may well have us seek out science to answer others. Alfred North Whitehead stated in *Science and the Modern World* (Macmillan, 1925) that "faith in the possibility of science, generated antecedently to the development of modern scientific theory, is an unconscious derivative from medieval theology." In his critically acclaimed book *The Genesis of the Copernican World* (MIT Press, 1987) Hans Blumenberg points out that many of the radical ideas put forth by Copernicus would not have gained acceptance were it not for forces already gathering strength within the Catholic Church that were sympathetic to them. Shifting the Earth away from the center of the cosmos was quite congenial to those who felt that an omnipotent and omnipresent deity need not be constrained to "create" at any one special place.

Finally, as Jews, we take no comfort in the assertion that our more argumentative form of religious observance enables us to succeed as physicists. There was a previous time and place when a Jewish "style" of doing physics was also suggested, and it was hardly meant as an accolade then.

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7/92

CIPARICK REPLIES: Morton and Judith Tavel leap to conclusions that none of the over 100 letters I have received commenting on my PHYSICS TODAY letter mention. I anticipated comments like the Tavels' and was surprised that they didn't come.

The usual assumption is that my opinions reflect the traditional "canards" about males and females. All they reflect are the *fact* that women choose science careers that are different from those chosen by males.

The Tavels seem to think that all science topics are on a par with one another, with undifferentiated value systems and objectives, and all equally appealing. They make no comments on the "game playing" aspects of theoretical physics and math, which I said were more appealing to males.

If I seemed to concentrate on the "career orientation" aspect of science education (and not the liberal arts presentation of pure science, which is what science education should be about), the reason is that the trends in science education *are* career oriented. Witness the many articles on science education that concentrate on "recruiting" minorities and women (and others) for science careers. Our pre-college academic science courses *presume* a career or a science major. That is basically why they turn off most students in high school. The result of these courses is neither scientific literacy nor enthusiasm for science.

The religious and cultural questions I raised involve values that, especially in high-pressure science courses, are taught implicitly. And they just don't conform to the values of the students, and there is no time to discuss these issues.

The facts speak for themselves: Science flourishes in some cultures but not in others. There are no rules that state that individuals from the latter cultures cannot achieve in science. And within those cultures where science thrives, there are different ways of approaching science, emphasizing distinct aspects. There is no such thing as "Jewish science," but the percentage of Jews in the sciences is high compared with their representation in society. Don't tell me it's genetic: It is part and parcel with the common Jewish culture.

The Tavels seem to think that all students are champing at the bit with questions based on their curiosity. Actually, most are indifferent or, to repeat, have value systems that don't foster such questioning, especially when the science they are taught seems quite trivial and irrelevant. I'm not cynically blaming the students. In America, it is the "culture" (or lack of it) that fosters indifference. Would that teaching in general could stimulate questions, instead of the usual pattern in education: providing answers to questions never asked.

As for the influence of medieval theology, I agree. But contemporary fundamentalism has nothing to do with that theology! Fundamentalists do not "believe" as Paul described faith: "the substance of things hoped for." They "know": hope for nothing to come, are satisfied and saved, and accept the dogmatic authority of Scripture with no questions asked. Does anyone detect a parallel with some presentations of science?

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4/93