letters

Training for physical oceanographers

We have concluded, from talking recently with numerous undergraduate physics majors and from reading PHYSICS TODAY (February 1971, page 23; June 1971, page 66); that it would benefit the physics community to have available a concise description of the subject matter emphasis for beginning graduate students of physical oceanography as recommended by practicing physical oceanographers and practitioners in closely related fields.

To assemble such a description, a questionnaire was sent out to 88 scientists in the US. The recipients of the questionnaire were asked to consider the following hypothetical but typical situation: One is approached by a student who has a BS degree, with an undergraduate major in physics and a minor in mathematics, and who states that he is interested in physical oceanography. Further discussion discloses that his interest (quite reasonably) has not yet narrowed to any specific aspect of physical oceanography. He is interested in gaining an understanding of the physical behavior of the oceans, and now hopes to develop the insights and skills necessary to apply theory, mathematical and physical modeling and observation at sea to enhance his (and our) understanding of the oceans.

The student then asks that we outline a program for him for his first year of graduate work. Each questionnaire recipient was asked to *apportion 40 credit hours* work (about the amount of credit a student could earn studying full-time for an academic year plus a summer, and just about the total formal course work required at many institutions for an MS degree) among the nine general subject-matter fields listed in the accompanying chart. A list of these subjects with a number of "typical topics" listed under each of the subject-matter fields, was provided, because the terms used to designate these fields are not mutually exclusive, and their usage varies slightly from institution to institution.

The responses are summarized in the chart showing the mean number of credit hours recommended in each subject-matter field by the 41 respondents. The several topics listed in the last

category are some of those actually suggested by the respondents. Before we draw any conclusions from these results, we should mention reservations expressed by some of the respondents. Several felt that our questionnaire could not, or should not, be answered. They stressed that "each student requires special advice and guidance." A few were concerned that our unstated purpose was the preemption of future oceanographic appointments on behalf of those who hold PhD degrees in oceanography. One such respondent commented that "while I would not recommend *a priori* that a student study a basic science in hopes of later entering oceanography, a few individuals so trained should be accepted into the field." Another stated he felt "that to teach our program and keep it up-to-date we need a mix of staff members with some having degrees in oceanography and others in the standard disciplines such as physics, chemistry and biology."

It should be stated that the concern for shipboard experience was somewhat greater than one might surmise from scanning the results for Instrument and Measurement Techniques and Shipboard Practicum. One respondent commented that students should "learn these at sea on a cruise," which he excluded from the 40-hour total, while another stated that these two "fields are difficult to cover well in formal courses and are best acquired in thesis work." The latter suggestion would not have been agreed to by the respondent who remarked, "I think he should learn as soon as possible whether he likes going to sea for science."

Finally, we received the following opinion from a respected oceanographer, iconoclast and friend: "In my opinion formal instruction for physical oceanographers is a red herring. Better they should be trying to get some real work done and, if they have the guts and wit, learning in the process. Those oceanographers I have met whose acumen and ability impress me are all products of 'apprenticeship.' Each served his time under a really good, hard-driving research scientist. They have little in common otherwise."

It is clear from the chart that there is no uniform view held on the optimum formal training for a physical oceanographer. Still, we can identify a typical program from the responses tabulated. If we adopt a three credit-hour per course convention, such a typical program might consist of one or two physics courses, two mathematics courses, three courses in physical oceanography, two courses in geophysical fluid dynamics, individual courses in instruments and measurement techniques used in physical oceanography, shipboard field methods and meteorology, and finally two courses dealing with other oceanographic specialities.

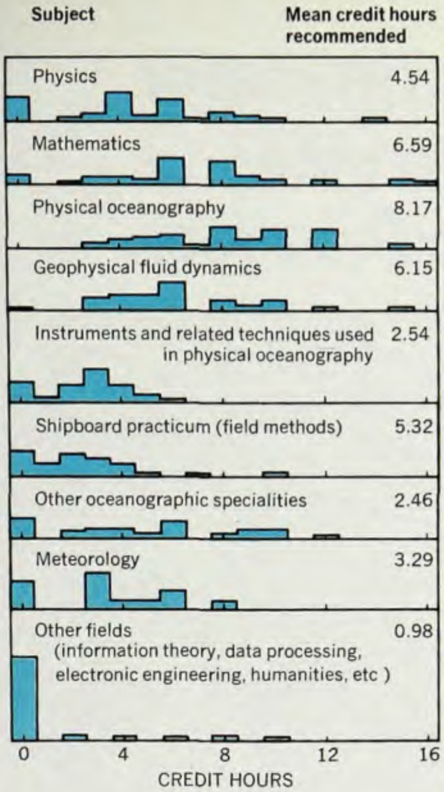
If the student reader of this article recognizes himself in the hypothetical student of the questionnaire, we suggest that he consider the range of recommendations incorporated in our summary chart. We particularly wish to point out the breadth of subject matter recommended for study. It would be well if a substantial portion of the topics suggested can be accommodated within the prescribed program of the department in which the student contemplates graduate study, be it a depart-

ment of physics, a department of earth and planetary sciences or a department of oceanography. If such flexibility of program is not present in any one department of a university the student is now considering, the student should investigate the feasibility of an interdepartmental graduate program. Indeed, some universities have adopted interinstitutional programs to accommodate the recognized needs of their graduate oceanography students.

If a potential graduate student has a clear perception of what aspect of physical oceanography he wishes to pursue, say, the theoretical study of the generation of waves, then the above suggestions may well not be applicable.

Going beyond the scope of the questionnaire, we would suggest that a student interested in a career in oceanographic research would benefit from developing a dissertation topic related to the oceans, regardless of the formal title of the department in which he is a graduate student.

EDWARD C. MONAHAN
The University of Michigan
Ann Arbor



More laser fusion

The new report in the August issue (page 17) on the AEC laser-fusion program omitted mentioning the AEC's funded fusion program at Sandia Laboratories, Albuquerque, New Mexico. Following the organization of their laser program in the mid-1960's, Sandia was the first US laboratory to have a functional, high-energy, picosecond, Nd^{3+} glass laser (see June 1969, page 60). In 1969 Sandia reported the first confirmation of Russian experiments on neutron production by picosecond laser irradiation of LiD.

Subsequently, many laser plasma experiments have been performed at Sandia on a variety of LiD and $(CD_2)_n$ targets, including slabs and thin films, aimed at clarifying the physics of laser energy absorption and its transport into the target. In the course of this research, target-laser feedback was established as a major problem in laser fusion experiments. Means to circumvent it have been developed and laser-plasma experiments utilizing over 50 joules per pulse have been conducted with both picosecond and nanosecond pulses. The Sandia program is now moving rapidly toward a four-beam (Nd^{3+} glass rod) irradiation capability for spherical implosion experiments.

A principle goal of the Sandia research is the development of intense radiation sources utilizing hot, dense plasmas. The Sandia laser-fusion program has grown steadily to the present annual levels of about $3 million and a staff of 50 people.

F. C. GILBERT
US Atomic Energy Commission
Washington, D.C.

A charged Sun?

In a letter in the September 1971 issue (page 13), C. J. Ransom called for a careful examination of Velikovsky's work. One of the points mentioned concerns a net charge Q on the Sun, or in its atmosphere, arguments for and against which have been given.[1] It is worth remembering[2] that the validity of Maxwell's equations have not been established for distances greater than about 10^{10} cm.

Some information on $|Q|$ can be obtained from the perihelion motions of Mercury[3,4] and, more particularly, Icarus[5]: the force between Q and a dipole moment it induces results in a perihelion advance rate δ. The value 2.9×10^{28} esu for $|Q|$ would give, for Mercury, $\delta = 3.4$ seconds of arc per century, the same as the effect of the solar oblateness determined by R. H. Dicke and H. M. Goldenberg, but only if Mercury is regarded as a perfect conductor and screening is neglected. For Icarus, the observed[6] δ agrees with general relativity to within 20%. Hence[5] if general relativity is accepted, then, to