letters

too slow to act, unionism has begun to respond to the need. While the approach of the common union is repugnant to the professional, various modifications, albeit unfamilar and untried, have been proposed.[2]

Indeed, novel approaches and ideas are urgently called for and new initiatives will have to be found and taken in developing solutions to the problems presented by Doyle. In the meanwhile we must take care that the lack of an immediate solution does not lead us hysterically to propose that other landmarks of professional stability should be surrendered in the name of equality to all ("Another [solution] would be for universities to eliminate tenure"), as though that could possibly help.

References

1. "Faculty Power: Collective Bargaining on Campus" (1972) and "Faculty Bargaining in the Seventies" (1973), Institute of Continuing Legal Education, Ann Arbor, Michigan.
2. C. M. Stevens, "The Management of Labor Disputes in the Public Sector" page 399, and M. C. Bernstein, "Alternatives to Strike" page 404, AAUP Bulletin (December 1972).

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Physics at AAAS

I would like to call the attention of your readers to the forthcoming Annual Meeting of the American Association for the Advancement of Science (25 February through 2 March 1974, in San Francisco). I think there is much in this meeting—and in other functions of the AAAS—to interest physicists that scarcely overlaps with the activities of the APS. Rather, the AAAS is designed to complement the more specialized discipline-oriented societies.

The preliminary program of this meeting appeared in the 26 October 1973 issue of *Science*, and future issues will carry further information. The program is made up largely of portions arranged by the twenty AAAS sections (which are listed, along with their officials, on the index page of each issue of "Science"). At past meetings we have found that talks that would be appropriate to an APS "general-interest session" are too specialized for the AAAS meetings: Few people in the physical sciences use the latter as professional meetings. But for broad-ranging popular treatment of the main topics of science and its interdisciplinary developments they are unique, and we have arranged the physics input for the San Francisco meeting accordingly. Thus it will include: the inimitable Ray Bradbury to tell us what physics and other sciences are doing to and for Man and his dreams; talks by physicists on their hobbies that require little equipment to explore profound ideas in physics ("Science for the Naked Eye"); a broad sketch of the progress towards fusion power and other such sessions.

I hope that many physicists will find this meeting of interest and will join us in San Francisco. And I can only encourage the membership of the APS to participate in the other activities of the AAAS, and to send us their ideas and criticisms to help us improve that participation.

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Fusion energy limit

Several recent articles on controlled fusion have stated that the deuterium in the oceans is a "virtually inexhaustible source" of energy.[1] These statements are true only if growth of energy usage is stopped. In round numbers the recoverable energy content of the deuterium in the oceans is 4×10^{30} joules, assuming the d-He^3 reaction is used and 25% overall recovery. Present world energy use is about 2×10^{20} J/yr. Thus at *present* rates, there is a 20-billion year supply, and the term "inexhaustible" appears appropriate.

On the other hand, a growth rate of 3% per year means that the same supply will be exhausted in only 684 years! Of course, by the end of that time the rate of energy consumption would be almost 5×10^4 times the solar energy intercepted by the earth, and clearly untenable. The 3% annual growth rate used above is composed of a 1% growth in per capita power[2] and a 2% growth in population. If one assumes zero population growth and a 1% annual growth in energy usage, the deuterium supply still lasts only 1921 years. If the supply figure is too small by a factor of 4 (supposing complete recovery), the fuel will last only two more doubling periods, or 140 more years at 1% growth.

These comments are not to detract from the fusion energy program, for it indeed is our largest stored energy source and has quite modest environmental impact. Rather they are meant to point out the staggering implications of growth, using the most forceful example I know. If one takes a more rational approach to how long an energy source will last, one can show that fusion energy indeed will last a long time. If we suppose a stabilized world population of 16×10^9, with a per-capita power usage of twice the present US figure of 10^4 watts the annual usage would be 1.0×10^{22} J and the deuterium would last about 4