

dialog of the film. It also contained a list of the participants, a set of questions for use before the film, another for use after viewing, a suggestion for a class project and a short bibliography. It is the reviewer's personal opinion that this guide at least doubles the value of the film.

The film was not too technical in its approach and where technical terms were used they were explained. The film's best use would probably be in a class where the origin of the solar system is being discussed but could also be used if the moon, the mass spectrometer, age dating of rocks, neutron activation, particle tracks or mineral formations were being discussed and applications and interactions with other studies were to be stressed.

The grade level for the use of the film would range from about eighth grade through college. For the lower grade levels a teacher should be prepared to answer questions raised by the film and here the teacher's guide would be most helpful.

The film would be meaningful in a high school chemistry, physics, earth science or general science course. In college it could be used in a descriptive astronomy course, one of the more informal science courses or presented to science

majors as program material in meetings of special interest groups such as ACS, SPS, or honorary societies.

The photographic and sound quality of the film was good. The scientific content could not be easily faulted as it came directly from major investigators. An exception is found in the dialog the announcer used to bridge the transition between interviews. Near the beginning of the film the announcer states that each color in a picture of a thin section of rock under a polarizing microscope is a different mineral. Later he states that most rocks on earth are not older than 20 million years. These statements do not affect the major thrust of the film and might not even be noticed except by a fussy reviewer.

The general approach of the film is excellent and it is hoped that more films showing scientists at work and discussing their work might be produced by others. Firsthand information from working scientists is much more exciting than the edited and interpreted versions of such information usually found in media presentations.

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**Fusion: The Ultimate Fire.** Produced by Jim Veilleux. Distributed by BFA Educational Media, 2211 Michigan Ave., Santa Monica, CA 90404. 32 mm, color, sound, 14.5 min. Price: \$195 purchase, \$16 rental. (Reviewed by Richard K. Osborn.)

I had the opportunity to show this film to quite a few people with technical training ranging from none at all to considerable—all acutely conscious of the existence and importance of fusion research. Their reactions (as well as my own) were uniformly enthusiastic. All felt that it was visually beautiful, well narrated, and intellectually stimulating. Several volunteered the interesting observation that, if it were run continuously in some public place such as a mall, it would draw a crowd—many persons staying with it more than once through.

The film is nicely balanced—consisting of approximately three equal parts: motivation, explanation of the physics of fusion, and description of ongoing research. I felt that the motivation of the need to exploit nuclear fusion as an energy resource was presented effectively and understandably. I do regret that the narration contained the simplistic assertion (frequently quoted elsewhere) that our fusion energy resources are virtually inexhaustible. If the world's energy use continues to escalate at the rate of three percent per year, our fusion energy resources will last less than a thousand years.

The second third of the film cleverly and comprehensibly presents the essence of the physics of nuclear fusion. The ideas are pictorialized in animation and lead smoothly from electron reconfigurations characteristic of the familiar chemical reactions to nucleonic reconfigurations that are involved in nuclear fusion. In the process, one is led naturally to some comprehension of the necessity for the extremely high temperature required for ignition of the fusion fire. The climactic scene in this segment is somewhat confusing and misleading. Two deuterons (not named and properly so) come together and a fusion event occurs. The

screen lights up to dramatize the huge release of energy (electromagnetic radiation perhaps?), a particle whizzes by (a neutron I suppose), and a nucleus consisting of three nucleons seems to be left behind and is apparently referred to as helium. This is correct for one branch of the D-D reaction, i.e.,  ${}_1\text{D}^2 + {}_1\text{D}^2 \rightarrow {}_2\text{He}^3 + {}_0n^1$ , except that the helium nucleus should have whizzed away also. The flash of light, incorrectly implying the emission of electromagnetic radiation, I allow under the heading of poetic license. This tiny scene stuck in the craw of several viewers with some to considerable technical background, but would in no way bother the audience at which this film is aimed.

The final third of the film is devoted to describing fusion research today. The two major attacks on the problem—magnetic confinement and laser ignition—are treated evenhandedly. Some of the magnetic confinement research being conducted at the Los Alamos Scientific Laboratories is pictorialized and described. The narration is necessarily oversimplified, but the basic ideas are simply, directly, and accurately presented. Some of the enormity of the effort must come through to the viewer by virtue of the beautiful photography of the monstrous machines. Then we are taken to the Lawrence Livermore Laboratory to see and hear a bit about laser-driven fusion research. Again, the basic ideas are presented and briefly sketched in animation. Some components of the big lasers presently in use are photographed, and pictures of the model of the big experiment to come are shown. Here, too, the magnitude of the effort is visually dramatized.

This film should prove informative and stimulating to students in middle and high schools and non-technically trained adults. Because of the importance of the subject matter, I hope that it will enjoy wide circulation.

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