high value of the printed discussion throughout both volumes. Three papers describe problems associated with the use of labeled substances in biological studies. Instability of the label and isotope effects are not new to biological workers, but the problems are more acute with tritium than any other tracer.

The last two-thirds of the volume is devoted to biological uses. These include radiation effects and metabolic studies of nucleosides, hormones, and vitamins in normal and pathological conditions.

By means of labeled thymidine which is taken up in the nuclear components of the cells and by virtue of the very short range of tritium beta rays, radiation damage can be highly localized and studied separately from general radiation effects. Three papers reported such studies on plant roots, bacteria, and malignant tissues.

Eighteen papers were devoted to cellular metabolism studies, mostly involving tritiated thymidine and concerned with DNA synthesis. Autoradiography is used in this work more frequently than counting techniques. The small beta-ray range enhances the definition obtained by the film technique. An outstanding paper revealed the origin and fate of inflammatory cells evoked by antigenic reactions. In addition, a thorough discussion of radioautographic procedures was included. Other papers not involving DNA were concerned with the metabolism of cholesterol and thyroid and adrenal hormones.

These volumes give a comprehensive picture of present-day tritium techniques and accomplishments. No matter what field he works in, the investigator who uses tritium will find useful information and references here. Much of the material has been published in specialized journals, but no one's reading is likely to be so omnivorous as to have included it all. If the sections on labeling compounds had been put in Volume I, most nonbiologists could have done without Volume II; as it is, we expect that most readers will want both volumes. The IAEA staff is to be commended for a useful service, well done.

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(About the reviewers: D. E. Hull is a Senior Research Associate and B. A. Fries a Research Associate at California Research Corporation, where they have collaborated for fifteen years in developing applications of radioactivity in the petroleum industry. Hull was at Minnesota, Columbia, and Oak Ridge before going to his present position, while Fries was at Chicago, Oak Ridge, and Hanford. Their experience in radioactivity goes back to their Ph.D. theses. Hull received his degree in physical chemistry in 1935; Fries in physiology in 1941, both at the University of California.)

Physics of Fast and Intermediate Reactors, Volume II. Proceedings of a Seminar, Vienna, 1961. Published by International Atomic Energy Agency. 407 pp. $9.00.

Anyone interested in fast and intermediate reactors is certainly going to want to study this volume for himself, for there is a great deal of valuable material in it.

The editors have divided it into sections on (1) calculation methods, (2) effects of cross section errors, (3) reactivity effects, (4) long term effects, and (5) reactor concept studies. The emphasis of a large part of this work is the comparison of various calculations with each other and of assumed cross section sets with each other. Without disparaging the work reported on, one would still like to see more included on comparison of theory against experiment.

The contents are briefly as follows:

Section 1. This part starts with a review by Marchuk of some of the methods used by the Russians in analyzing reactors. These include multigroup, P_n, and S_n methods which are more or less familiar to most people; however, they appear to go farther with the analytical attack in many instances before putting the problems on the computer. A great deal of use is made of adjoint solutions. It would have been an editorial kindness to provide translations of this and other Russian papers.

Moinereau and Solanes, and Pendlebury and Underhill discuss the influence on computed results of changing integration step sizes, order of the approximation to the angular flux, transport approximation, and two- vs. one-dimensional calculations. These subjects are not entirely new, but it is helpful to have this material presented with the care and organization shown here.

Zelazny and Kuszell's analytic treatment of the multigroup transport theory points toward useful results, but it would be more useful and convincing to see some applications here. Haggblom's multigroup analysis of the reactivity effect of an air gap appears to be an improvement, but it appears that the problem is not closed yet.

Section 2. Effects of cross section errors on multiplication and breeding ratio are discussed by Moinereau and Solanes, Pendlebury, and Moorehead. It would have been interesting if these authors had had the opportunity to add material for inclusion in this volume comparing their results where possible. Whether or not the estimates of the influence of errors in the various cross sections will be instrumental in getting better cross section measurements, they are of considerable use, as Pendlebury shows, in adjustment of cross section sets to fit families of critical experiments.

Sections 3 and 4. Bhide and Hummel find that use of improved cross sections for sodium, steel, and oxygen obtained from a very fine-structured multigroup calculation gives a more positive sodium coefficient. Yiftah likewise finds the sodium coefficient to be more positive when higher plutonium isotopes are present in the reactor, and at the same time he discusses the effect of these higher isotopes on critical mass and breeding ratio for a number of reactor systems.

Okrent's very comprehensive paper presents material on most of the topics already mentioned as well as information on the approach to equilibrium of isotopic content in long burnups, fission products, influence of recycle and cross section uncertainties, on sodium coefficient, and much more; and the results are related in a fashion particularly easy to follow.

In a study of long burnup Ott and Jansen find the time variations of isotopic composition of reactors under two possible schemes of fuel recycling. The steady state compositions and breeding gains are also given.

Soodak's calculations of reactivity effects of hydrogen addition are interesting both for their bearing on reactor safety and for the physical insight this work gives into the interplay among leakage, absorption, and alpha variation over wide spectrum variations.

Other subjects covered in these sections are poison

burnup by Toshinsky and Kalashnikov, fission gas pressure buildup by Engelmann, fission product burnup by Levine, and a discussion of perturbation theory by Webster.

Section 5. The reactor concepts include studies of cermet and ceramic systems and some combination fast-thermal systems. In the former, Codd *et al.* discuss heterogeneity effects and methods of combining cell calculations with over-all reactor calculations, and also some estimates of Doppler effect in U^{238} and Pu^{239} in fast reactors. Toppel and Avery discuss the effects on generation time of various power divisions between the fast and thermal sections of their reactor systems, and they show how the balance can be improved by the use of an auxiliary superheater.

Kania *et al.* present a coupled physics and economics study of several alloy, ceramic, and cermet systems in considerable detail and give estimates of optimum specific power and burnup under a number of conditions of reprocessing and cost factors.

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(About the Reviewer: Melvin M. Levine has been a member of the Theoretical Reactor Physics Group at BNL for the past three years. Before that, he was a reactor physicist at the Babcock and Wilcox Company Atomic Energy Division for four years. He did his graduate work at the University of Virginia. He has done work in fission product poisoning, resonance absorption, and breeding studies.)