

simultaneous momentum measurement will then give the mass of the particle, and this is what we need for discovering heavy, stable or semi-stable particles produced at large angles by colliding beams.

At this point one may ask what is the probability of production, per interaction, of a pair of such heavy, strongly interacting particles, say a quark 15 times heavier than a proton? The rule of thumb is:

$$\begin{aligned} \text{probability per interaction} &\approx (m_\pi/M)^2, \\ \text{giving } \sim 10^{-4} \text{ with } M &= 15 \text{ GeV,} \\ (m_\pi &= \text{mass of } \pi \text{ meson).} \end{aligned}$$

Since a system of large and fast scintillators can cover a solid angle of about 0.1 sterad, the rate of measurable events could be about 100 per hour — a comfortable one — if these particles exist.

Why go on?

I cannot finish without asking the general question that involves us all. Why do we want to know these things, and *urgently*? Could it not be that we are a cast of maniacs, who try to solve problems created only by our machines, problems not at all important for the equilibrium of nature, the nature we live in?

If that were the case, if our pure science were so pure as to be of no foreseeable utility, then I fear that in the long run Society would stop us from progressing so fast. We begin to be a burden to Society when we go on asking for larger and costlier accelerators.

My answer to these disturbing questions is that, practical applications apart, we are not so queer and that our problems are not Byzantine. My faith comes from the fact that there are places in the universe where

matter consists uniquely of particles having an energy of 10^{12} – 10^{13} eV each, and these places are light years in dimensions and contain a number of particles equivalent to millions of suns. I have in mind, of course, the centre of the radio galaxies.

Mesonic matter is thus not only produced in the odd situations present in our accelerators (or in the even more odd one that will be created by colliding beams), but it is also the basic matter at the centre of not-so-rare galaxies. Possibly even the apparent rarity of these objects is due to the fact that galaxies remain in those conditions only for a small fraction of their evolution. Perhaps all galaxies, all of us, went or will go through that stage. Thus the GeV, the TeV world* cannot be an abstraction, since it is deeply connected with the nature that surrounds us. It is even imaginable that in time we will be able to exploit it to our advantage.

The parallel with stellar evolution is too banal for us to dare to think that, *mutatis mutandis*, it will be applicable in this case. But I cannot help recalling that what, forty years ago, looked like the impossible problem of understanding how the centre of the sun kept on burning is nowadays reduced to the still difficult but not so impossible problem of making nuclear energy economically competitive with coal burning.

Can we afford to be ignorant about these problems; can we avoid asking what is the equation of state of matter at these excitations, what are the properties of a mass collapsing towards the relativistic limit? Can we afford to wait? According to the rules of the human game, we must go ahead, and as fast as we can. ●

* TeV: 1 Tera-electronvolt = 10^{12} eV = 1000 GeV.

BOOKS

Nuclear radiation detection, by William J. Price (New York, McGraw-Hill Book Co., 2nd ed. 1964; \$12.75).

This volume is the second edition of a text-book developed for use by students of the Nucleonics Instrumentation Course at the U.S. Air Force Institute of Technology. In the book, according to the author, 'an attempt is made to collect the basic information on all the important nuclear-radiation detectors in use today... including sufficient specific information to enable the reader to select his own detection equipment and, in many cases, to apply it'. Although not explicitly stated, the main emphasis is on those problems and techniques most frequently met in reactor physics, low-energy nuclear physics and dosimetry.

The first chapter covers many of the essential aspects of the interaction of radiation with matter, treating particularly proton, neutron, electron, gamma-ray and fission-fragment interactions. This, together with the next two chapters, surveying detection methods and the statistics of detection systems generally, provides a foundation for the more detailed study of detectors in the following sections.

Succeeding chapters are devoted to ionization chambers, Geiger-Müller counters, proportional counters, scintillation

detectors, and semiconductor radiation detectors. The chapter entitled 'Photographic emulsions and other detection methods', which briefly mentions cloud chambers, bubble chambers and spark chambers, includes a section on chemical and calorimetric techniques. A separate chapter is devoted to methods of neutron detection, because of the special problems involved and because of the importance of neutron measurements. In the concluding chapter a more detailed treatment of the electronics used for nuclear-radiation detection is given.

The scope of this single volume is large; consequently, the treatment is mainly descriptive and little attempt is made to derive most of the equations used. Nevertheless, much quantitative data are given and a useful guide to students is provided by means of frequent numerical examples interspersed throughout the text. A good balance is obtained between practical and theoretical considerations and, on the whole, the aims of the author can be considered to have been largely fulfilled.

Although the treatment is generally concise and the presentation logical there are, occasionally, passages which are either misleading or not altogether clear. For example,

Continued on p. 108



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the variation of photomultiplier single-electron pulse amplitude is due to the statistical nature of the multiplication process rather than to any 'variation in secondary-emission ratio', as stated on p. 181. In discussing noise in pulse amplifiers on p. 381, it is not 'the low resistance associated with a short clipping-time constant...' that would make '... thermal noise intolerable', but rather the correspondingly increased bandwidth; indeed, the noise generated by the resistor decreases with its resistance. The fact that the d.c. feedback amplifier on p. 406 is phase-inverting is not mentioned, and there is confusion in the application of the appropriate sign, which appears correctly in some equations and wrongly in others. No explanation is given here of the virtual-earth principle and it is by no means clear that 'the amplifier (of gain G) is seen to act as a current amplifier...' with the feedback acting such that '... the input capacitance C is reduced to $C/(1+G)$ '. The time constant of the input circuit is indeed reduced to $RC/(1+G)$, but because the feedback reduces the input resistance R to $R/(1+G)$ rather than affecting C .

Many additions have been made since the first edition, and the extensive set of references has been largely brought up to date. Newcomers to the field of nuclear radiation detection should find the book useful, and the chapter devoted to semiconductor detectors should prove valuable as an introduction to the subject. Notable omissions in the range of topics covered are time-of-flight techniques, and only very little space is devoted to multichannel analysers. On the other hand, it is difficult to see why any space was devoted, for example, to bubble chambers in a volume which otherwise almost completely ignores high-energy radiation.

B. Z.

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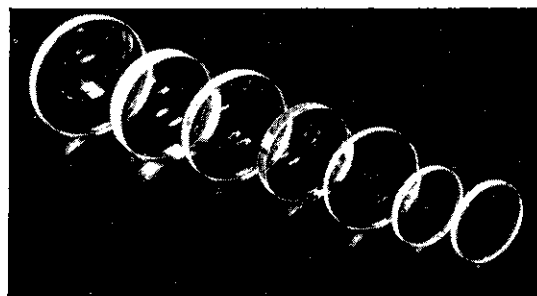
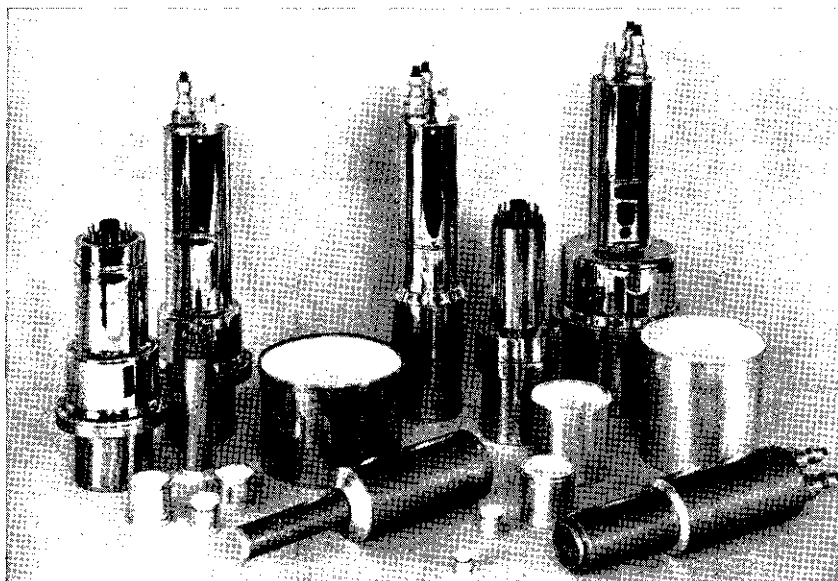
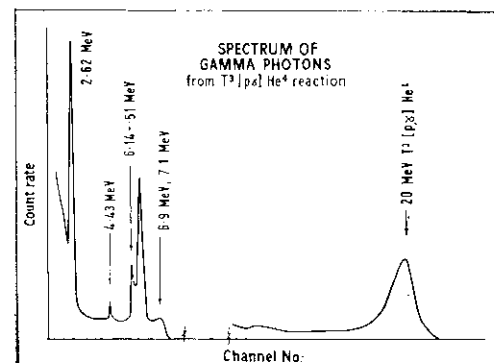
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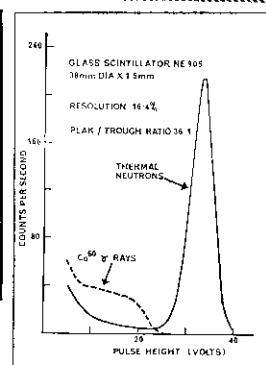
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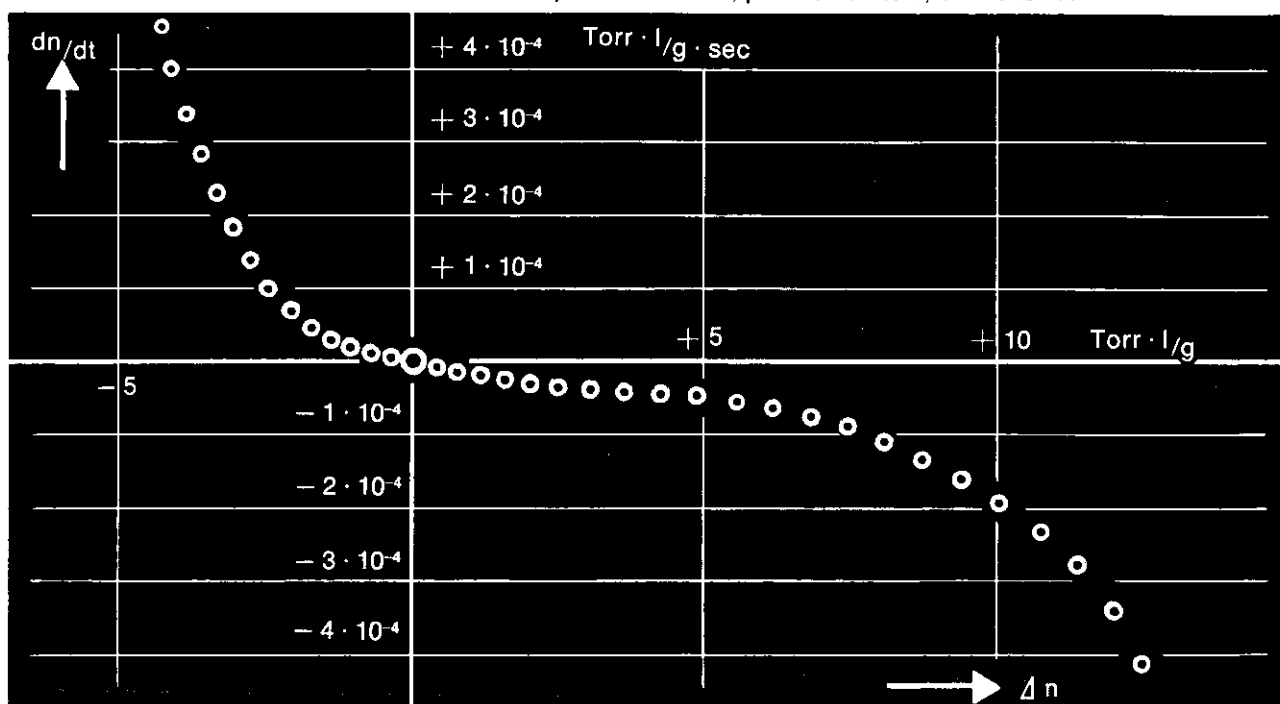
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