his day." They state that "it was he who first demanded that observation *and* logic join hands in natural philosophy . . . that Anaxagoras never allowed his physics to fall wholly into the realm of abstraction and fantasy, or to be found entirely by the appearances perceived by the senses."

Well and good and proper for a credo even today. The question is how this demand was met and whether indeed it led Anaxagoras to concepts which are not only similar in sound, but also in meaning. Anaxagoras, for example, conceived of infinitesimals that were not too far (in size at least) from those we know today. The question is whether this conception approached (if you will pardon the expression) today's meaning. Here is a résumé of the argument: Observation (of the infinite variety of nature and its "never-ending change") led Anaxagoras to a construct in which everything is infinitely divisible and everything contains at least some of each element, its nature being determined by what element in the mix predominated. And to allow for other conditions (such as stability) the authors say:

> The only way however that an infinite variety of stable entities can exist in a finite object is for the entities to be *infinitesimal in size, because an infinite number of entities* can be contained in a finite volume only if they are infinitely small. Anaxagoras realized that this is so and was thus led to postulate explicitly that the basic units of matter—the fundamental building blocks out of which all objects are made—are infinitesimal in size.

Then, explaining it was well known that an infinite number of points could not make an object of finite size, and that an infinite number of finite objects would occupy an infinite volume, the authors go on to say:

> The entities Anaxagoras called infinitely small were infinitesimal in precisely the sense in which the word has been used since the seventeenth century; they were magnitudes whose measure is larger than zero but smaller than any arbitrarily small number. Anaxagoras was to the best of our knowledge the first to introduce infinitesimals into a physical theory.

This is the same straining which associates Democritus' atoms with ours. They are related in name not in concept; they are the children of logic, not of experiment. In fact the authors even seem to "admit" this in the sentence which follows immediately—

> It might be added that the difficulties which he and his successors encountered when using these new quantities were in no small measure responsible for the complete abandonment of infinitesimals in science and in mathematics for some two thousand years after his time.

I do not wish to belabor this point but this example of labeling the ancient and the modern positions and then assuming by hindsight that Anaxagoras *could* have meant what connects them occurs throughout the book. If Anaxagoras really had officiated at the birth of scientific method perhaps we would, today, have had the experience of where it might lead us.

There was science before there was scientific method, and it is unfair to Anaxagoras to dim his lustre as a natural philosopher, as an observer and as an experimenter by indicating he anticipated modern concepts over a vast range of subjects when it is so highly improbable.

**Atomic Collision Processes.** Conf. Proc. (University College, London, July 1963). M. R. C. McDowell, ed. 1165 pp. (North-Holland, Amsterdam) Interscience, New York, 1964. $38.50.
*Reviewed by C. E. Kuyatt, National Bureau of Standards.*

The enormous growth of research on atomic collisions in the last decade is amply demonstrated by the size of this volume, which contains the complete proceedings of the Third International Conference on the Physics of Electronic and Atomic Collisions, held at University College, London, from July 22 to 26, 1963. Nearly all of the prominent groups in the field, both theoretical and experimental, are represented among 140 papers.

Nine review papers were given at the conference and all are reproduced in full: "The Present State of the Study of Atomic Collisions" by H. S. W. Massey, "The Excitation

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# SYLVANIA ELECTRONIC SYSTEMS

and Ionization of Atoms by Electron Impact" by D. W. O. Heddle and M. J. Seaton, "Inelastic Electron-Molecule Collisions" by C. A. McDowell, "Electron-Ion Recombination" by D. R. Bates, "Inelastic Heavy Particle Collision Processes" by A. Dalgarno, "Elastic Scattering of Atoms and Molecules in the Thermal Energy Range" by R. B. Bernstein, "Afterglow Atomic Collision Processes" by M. A. Biondi, "Collision Processes Leading to Optical Masers in Gases" by C. K. N. Patel, and "Muonium and Positronium Physics" by J. M. Bailey and V. W. Hughes. Taken together, these reviews cover a wide area of collision physics and provide many references.

The contributed papers are divided into twelve sections: slow electron scattering by atoms, resonances (in electron scattering), polarization of radiation emitted on electron impact, excitation and ionization of atoms by electron impact, further theory (mainly electron-atom collisions), electron-molecular collisions, recombination, negative ions, photo-processes, inelastic heavy particle collisions, elastic heavy particle collisions, collisions with molecules, and other topics. In several cases papers appear to be placed in the wrong sections. For example several papers which would logically be expected under "excitation and ionization of atoms by electron impact" appear under the headings "resonances" and "polarization of radiation emitted on electron impact".

Two discussion sessions were held at the conference and transcribed for the proceedings. The theoretical discussion session centered on various approximations used in scattering calculations. The session on experimental problems dealt with crossed-beam experiments involving charged-neutral, charged-charged, and neutral-neutral particle interactions. Some of the problems discussed were: detection of neutral beams, determination of excited-state concentrations in neutral beams, low-noise ion sources, and the perturbation of one charged beam by another.

As is often the case with conference proceedings, the papers are variable in quality, but taken as a whole provide a good cross section of the state of collisions research at the time of the conference. All serious workers in collision physics should have access to a copy of this volume, but because of its high price, it is likely that this access will be through library rather than individual ownership. For those with neither, it should be noted that reprints of many of the articles are available from the authors.

**Space Physics and Radio Astronomy.** H. Messel and S. T. Butler, eds. 174 pp. St. Martin's Press, New York, 1964. $4.25.
*Reviewed by H. J. Hagger, Albiswerk, Zurich, Switzerland.*

Space physics and radio astronomy are the fields of scientific research which are most admired by many people, and they also have the working medium in common, space. This book is a record of a series of lectures given for science teachers by world experts at the third Nuclear Research Foundation Summer School in Australia. Each section, written by a competent author from an Australian university, gives a very brief survey of its topic, but the book as a whole does not hold what one would expect under such a title. It is to some extent a collection of selected knowledge, with Leonardo da Vinci and Michelson as starting points and ending with the Australian radio telescopes and the first man-made satellites.

The first two chapters deal with some results of radio astronomy in general and the design of the 210-ft Australian radio telescope in particular. The third chapter shows some future projects of radio astronomical research both in Australia and elsewhere. The next two sections expose problems in resolving power of interferometers with some application to radio frequencies. In chapters 6 and 7 we learn some facts about meteor astronomy and about conclusions from observations of the physics of the upper atmosphere. Chapter 8 extends these remarks to the phenomenon of aurorae and its relationship to the Van Allen belts. Chapter 9, on elementary mechanics of flight, starts with the first tries in free flight and ends up with aerodynamical stability.