eventually transmitted via Spain to France and England. Minute mathematical clues can provide firm evidence of cultural links that might not be suspected at first sight.

The many excellent original drawings are collected together in Part Three and it is convenient to have the third volume open at the appropriate figure when reading from the text in the other volumes. Part Three also contains explanatory appendices on chronology, astronomy and mathematics, an extensive bibliography of course material and nine monochrome plates.

In summary the present reviewer can do no better than echo the views of Willy Hartner, an eminent scholar of ancient astronomy who comments: “it seems inconceivable that one brain can fathom the wealth of details contained in this gigantic work and be capable of presenting them to the reader in such an attractive way”. Probably few individuals will be able to afford to buy this history for their personal library, but it is a book that should be available to the serious student of ancient astronomy.

Ian Elliott


During the 1960’s and early 1970’s a large number of new phenomena were discovered in astronomy. The list includes the radio galaxies and Quasars, the 3°K background radiation, pulsars and the plethora of X-Ray emitting objects such as the binary X-ray sources. I have always been struck by the fact that, while satisfactory progress has been made in the understanding of the origins of nearly all of them, the Quasars and the powerful radio-emitting galaxies seem to remain an enigma after 20 years of investigation. It is true that there are still many details of the available models of neutron stars, for instance, that require clarification but the broad outlines of the interpretation of the relevant data have achieved a wide measure of acceptance.

Why is it that the Quasars and like objects stubbornly deny the investigator a satisfactory explanation? Part of the answer lies in their immense distances. They are among the most distant objects known in the Universe. So, in spite of their very great luminosities, spatial resolution is difficult to achieve. Thus we cannot “get inside” a Quasar or distant radio galaxy and compare its constituents with those familiar objects in our own galaxy. A second aspect of the problem lies in the timing of the discovery of the Quasars. In the early 1960’s when they were first recognized our knowledge of even the nearby galaxies was in a much more rudimentary state than at present. So our ability to interpret what we saw was correspondingly more restricted.

It was therefore fascinating to read the excellent review material presented in this volume by the world’s foremost experts in the field. Nine of the fifteen papers concentrate on interpretation of the observational data in terms of the physical conditions in the galaxies concerned. The remaining six reviews discuss modelling of the various aspects of the problem with a heavy dependence on the presence of Black Holes. As seems to be usual these days absence of detailed observational data permits the theoreticians to rely heavily on that often discussed but as yet undiscovered object, the ubiquitous Black Hole.
The introductory chapter by Cyril Hazard of the Cambridge Institute of Astronomy summarizes a great deal of what follows in fairly non-technical language for those who may not feel they want to plough through the more detailed and more rigorous chapters which follow. The most striking result of recent work is the fact that Quasars are not an isolated phenomenon. There is a steady gradation of properties moving from the normal galaxies through the radio galaxies, the Seyfert galaxies to the Quasars themselves. Properties such as the widths of the emission lines or the degree of ultra-violet excess appear to increase as one goes through this sequence. So too the mean redshift and therefore presumably the distance increases in the same manner. This probably reflects the fact that the Quasar phenomenon is relatively rare or relatively shortlived and so their mean space density is low. The continuity of properties is extremely useful since it means that we can study the phenomenon which occurs in the more distant objects in nearby objects too, albeit on a less extreme scale.

A generally-accepted phenomenological model would appear to be one with a compact source of non-thermal radiation in the nucleus of such galaxies exciting the surrounding low-density interstellar gas into emission and into turbulent motion, which accounts for the width of the observed lines. This picture leads to an interesting interpretation of the BL Lac objects. They possess a featureless non-thermal continuum but otherwise look like quasars. They have another very characteristic feature however in that the continua are highly polarized. The suggested relationship between these and the Quasars is that substantial amounts of interstellar gas are missing from the BL Lac objects and so we look directly into the central non-thermal source. This would also account for the fact that BL Lac objects vary more rapidly and in a more extreme manner than in the heavily gas-blanketed Quasars.

All of this progress however does not solve the basic problem with the ‘active galactic nuclei’ as the family of objects are now called i.e. their very high luminosity combined with an apparently highly compact nuclear source. The small size of the underlying source was originally deduced from the light-travel time argument. This would argue that if, as is observed, active nuclei are to vary by a significant proportion of their total output in times of weeks, then the dimensions of the source cannot be greater than light-weeks. Direct observations of active galactic nuclei, especially in the radio region of the spectrum by use of very long baseline interferometric techniques, confirm these implications.

So this book is by way of a status report on work in hand and on directions for continuing investigation. The level at which it is written will suit students or research workers, but those with a general interest who are willing to concentrate a bit on what they are reading will find that they learn a great deal from it. I would think it a must for libraries. Unfortunately the copy which arrived for review had no price attached. It is a well produced book however, conforming to Cambridge University Press’ usual high standards. Three indices are provided, one according to subject, one according to object names and another according to the names of the authors mentioned in the text. The object name index could well be very useful to those working in the field.

31st July, 1980

P. B. Byrne