restricted to Wiesel, but also gives a broader history of optical crafts in Augsburg. A description of the social and economic background as well as the history of science (i.e. mathematics and astronomy) in Augsburg around 1600 forms the first part (pp. 21–37). The second part comprises opticians active in Augsburg from the seventeenth to the mid-nineteenth century. Here the life and professional activities of Johann Wiesel are treated at length. Coming from the Palatinate, Wiesel in 1622 opened a workshop in Augsburg. From 1625 onwards he used screw threads for adjusting his microscopes and very likely he first introduced the field lens to enlarge the field of vision about 1650. His commercial contacts all over Europe have been reconstructed with painstaking diligence and accuracy. The author also describes the activities of Daniel Depiere (1615–82), Wiesel's son-in-law and successor, and of Cosmus Conrad Cuno (1652–1745), who later married Depiere's widow (his third wife). Contrary to the broad treatment these three person received, the remaining opticians are described in short chapters on pages 186–98. Instrument-making in Augsburg reached its last peak with Georg Friedrich Brander (1713–83), who produced reflecting telescopes, glass micrometers, microscopes, drawing and surveying instruments. However, on Brander alone some biographical addenda can be found in this book, because a substantial exhibition catalogue has already been published some years ago (*G. F. Brander 1717–1783: Wissenschaftliche Instrumente aus seiner Werkstatt*, ed. by Alto Brachner (Münich, 1983)).

The third part deals extensively with the instruments made by Wiesel, Depiere, and Cuno, that is, spectacles, refracting telescopes, microscopes, burning lenses, magic lanterns, and various optical toys. A special merit of this study is the consideration of the materials needed to produce optical instruments in the seventeenth century (glass, paper, cardboard, parchment, leather, ivory, horn). Generally this is an important topic which is not often treated adequately in historical studies on scientific instruments.

On pages 371–88 a summary in English is given. The appendices (pp. 423–78) contain transcriptions of product and price lists by Wiesel, Depiere and Cuno, a register with descriptions of the small number of extant instruments (only six items have survived to the present day), and texts of several letters and bills.

Keil has elucidated a rather unknown part of the history of instrument-making in Augsburg with admirable competence. Certainly this book will be the definitive study of the subject for many years to come.

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Mathematics and Logic

PATRICK SUPPES, JULIUS M. MORAVCSIK, and HENRY MENDELL, editors, *Ancient and Medieval Traditions in the Exact Sciences: Essays in Memory of Wilbur Knorr*. Stanford, CT: CSLI Publications, 2000. xi + 227 pp. US$24.50 (pbk). ISBN 1-57586-273-5 (cloth), 1-57586-274-3 (pbk).

This book, as the title suggests, is a commemorative volume recognizing the career of Wilbur Knorr, one of the foremost historians of the ancient mathematical sciences in the second half of the twentieth century, who died prematurely at the age of 52. The book consists of five papers given at a memorial conference, held at Stanford University in March of 1998, along with four papers, by colleagues of Knorr, which were not given at that conference. The papers, written for the specialist, treat a broad array of subjects in the ancient and medieval exact sciences. I will discuss only four papers in any detail. The papers which I will discuss take up more than two-thirds of the book's pages. I will mention the other papers only in passing.

Alexander Jones contributes a short study on an ancient approach to perspective, 'Pappus' Notes to Euclid's *Optics*'. Ian Mueller provides a paper titled 'Plato's Geometrical Chemistry and Its Exegesis in Antiquity'. A philosophical paper by Julius Moravcsik, 'Plato on Numbers and Mathematics', attempts to explicate Plato's theory of arithmetic. Charles Burnett furnishes some notes on Arabic numerals in Latin medieval texts, 'Why We Read Arabic Numerals Backwards'. Finally, David Nivison's paper, 'The Chronology of the Three Dynasties', uses calendrics and astronomy to throw light on Chinese chronology.

J. L. Berggren and Glen van Brummelen contribute a paper titled 'The Role and Development of Geometric Analysis and Synthesis in Ancient Greece and Medieval Islam'. The problem of explaining ancient geometrical analysis, and its relation to synthesis, is both vexed and much disputed. The advantage of this paper is that it avoids the technical apparatus of modern logic employed by many scholars, which translates ancient analyses into a mode of discourse alien to the original so that the reader loses sight of the ancient sources. The disadvantage of this paper is that it uses only two examples of ancient analysis, both taken from Archimedes. The authors begin by discussing the most significant ancient discussion of geometrical analysis, the introduction of Pappus' *Collection* VII, and contrasts this with Archimedes' *Sphere and Cylinder* II 4, which shows that, on a first reading, Pappus' description of the process of analysis and synthesis falls short of the sophisticated structure of Archimedes' practice. The next section is an attempt to elucidate the underlying structure of analysis/synthesis pairs and to vindicate Pappus' discussion based on this explanation. Whether or not they are successful at making Pappus agree with ancient practice, their discussion of the practices and the overall structure of the analysis/synthesis pair is quite helpful. They relate the analysis/synthesis pair to the ancient practice of *apogōgē*, or reduction, the transformation of one problem to a related problem, which if solved will solve the original problem. This discussion shows that 'the analysis/synthesis pair are as a method analogous to the earlier *apogōgē*' (p. 8). They then make the claim that the term analysis was used as a rubric for both parts of the analysis/synthesis pair, the reduction (a search for preconditions) and the deduction (a search through the consequences). The most interesting part of the paper is a discussion of the four stages of problematic analysis and synthesis with an accompanying diagram. They are careful to point out that in practice the process rarely moves through the four stages in order. Here they also argue that 'analysis, like many good mathematical tools, not only solved problems: it generated them' (p. 29). The paper next examines the developments of the technique of analysis in the geometric tradition of medieval Islam. This part of the paper is quite useful because the literature on analysis in Arabic mathematics is scanty. Firstly, the authors discuss a medieval discussion of analysis in Al-Sijizī's *Book on Making Easy the Ways of Deriving Geometric Problems*. Next they discuss the classification of geometric problems in Ibn Sinān's *On Analysis and Synthesis*. Both of these texts show that the Arabic mathematicians had concerns which were related to but distinct from those of the Greek geometers. After some examples of analyses in Arabic texts, we are presented with a discussion of the terms 'known' and 'given' in ancient and medieval texts. The authors point out that, in the Arabic texts, 'analysis by knowns was brought very much to the forefront, and became one of the standard problem-solving techniques', and that, 'such analyses established pure existence arguments as mathematical arguments in their own rights' (p. 29). The paper is, on the whole a clear and helpful addition to the scholarship on ancient and medieval geometrical analysis.

Reviel Netz also supplies a paper on Greek geometrical analysis, 'Why did Greek Mathematicians *Publish* their Analyses?' This question is explicitly raised in the paper discussed above (p. 15). Netz neither presents new evidence nor re-examines old evidence. He sketches out the full force of the question and adumbrates a preliminary answer based on views which 'form part of the recent consensus among historians of Greek mathematics' (p. 139). Netz first argues that analyses can be heuristic only in a very limited sense and that therefore we should see their presence in the mathematical corpus as part of the overall attempt to persuade us that the problem at hand has been solved. The question remains, however, since the synthesis alone should suffice to convince us that the theorem is true, or the problem solved. Netz's route is to examine the difference between problems and theorems. 'A theorem proves *that* something is true, and is therefore an end of a quest; a problem asserts *how* something may be true, and is therefore only a step in a quest, and a step which may prove wrong, which may be criticized' (p. 152). A theorem shows the truth of something based on certain preconditions, whereas a problem shows how something can be produced or found from given objects. Thus, there are many solutions to a single problem. What a mathematician wants to show is that his solution is a good one. The analysis may serve this end because, 'the analysis actually ends with—and therefore singles out as its aim—the key fact which is the "idea" of the solution' (p. 155). Netz concludes by claiming that Greek geometers included their analysis to give their readers insight into the nature of their solutions, in effect to help their readers to understand why their solutions are good ones. The paper is a fine elaboration of a good question; however, as Netz himself makes clear, much more evidence needs to be examined for a full treatment of the issue.

David Fowler attempts, in a paper titled 'Eudoxus: *Parapegma* and Proportionality' to explain, once again, Eudoxus' calendrical work on the basis of his own theory of the use of anthyphairetic ratios in early Greek mathematics. His theory is that the Greeks had a means of representing ratios which is mathematically equivalent to continued fractions and which, strangely enough, left only the most elusive traces in the texts that we have. As always with Fowler's work on the anthyphairetic ratio theory, the mathematics is interesting and compelling but its relation to the ancient sources is so tenuous as to cast serious doubt on the historical credibility of the whole project. If anything, Fowler's work shows us that the theory of continued fractions is a powerful theory and that it can be used to model a good deal of interesting mathematics.

The last paper that I want to discuss is 'The Trouble with Eudoxus' by Henry Mendell. This is the second of two long papers written by Mendell in an attempt to understand Eudoxus' theory of homocentric spheres and the ancient evidence which preserves this theory for us. There have been a number of reconstructions of Eudoxus' astronomical models and it is unlikely that we will ever know the full details of the theory. Nevertheless, Mendell has done yeoman's service in producing a reconstruction that is both explanatory of the sort of phenomena which are likely to have interested Eudoxus, and which agrees with a close reading of those texts which serve as our evidence for Eudoxus' work. The best ancient explanation of Eudoxus' models is found in Simplicius' *Commentary on Aristotle's On the Heavens* and is many times removed from Eudoxus himself. Because they were too much influenced by later developments in astronomy, many scholars have thought that Eudoxus' primary concern was to model retrograde arcs and, in attempting to fit models which do this with the text, they have had to claim that the text is wrong and that Simplicius is confused. Mendell's reconstruction reflects a growing consensus among historians of ancient astronomy that the Greek observational astronomy of Eudoxus's time was quite rudimentary. What is perhaps more significant, it reads the ancient sources as accurately reporting what Eudoxus did. The mathematics of homocentric spheres is not trivial and Mendell has explored them in detail in a previous paper. Here, he merely provides an intuitive discussion of the mathematics of rotating spheres along with indications of those theorems in the ancient spherics that could be used to vindicate his observations. The bulk of the paper is a translation of, and commentary on, all of the ancient evidence for Eudoxus' models. The sources are sifted along chronological lines so that we see what should be attributed to Eudoxus and what should be attributed to our sources, most of whom are writing with the intention of refuting Eudoxus. The final section of the paper is a clear presentation of Sosigenes' objections to Eudoxus' models which gives rise to some speculation on the nature of the demise of the theory of homocentric spheres. This is a strong paper which does much to clarify the difficulties involved with Eudoxus' theory of homocentric spheres.

The book is a suitable tribute to an outstanding scholar. One only wishes that the introduction had included a biographical summary of Knorr's career and that Knorr's bibliography, which is cited in the introduction, had been included in the book.

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Life Sciences

B. REGAL, *Henry Fairfield Osborn: Race and the Search for the Origins of Man*. Aldershot: Ashgate, 2002. xix + 219 pp., 13 plates. US$69.95/£40.00. ISBN 0-7546-0587-6.

Following the publication of Ron Rainger's study of Henry Fairfield Osborn (*An Agenda for Antiquity*, 1991) one might have wondered whether there was room for another. However, as Brian Regal points out, Rainger's approach was shaped by an analysis of the institutional framework through which Osborn acquired his reputation as a palaeontologist, palaeoanthropologist, and commentator on the race issue. Regal argues that a closer study of Osborn's personal development, especially in his early years, can throw light both on the nature and