Master Alfonso, the translator of this treatise …" (= "*Scivit enim Averoys optime Almagestum. Nam vidi per eum Almagesti abbreviatum, quem librum fecit transferre rex Alfonsus magnus, et habetur Bononie et in Hispania. Hec sunt verba magistri Alfonsi, translatoris huius tractatus*…") (Steel and Guldentops, 1997: 94–95). There are three Alfonsos here. The first is the author of the Latin text, Alfonso Dinis of Lisbon (d. 1352) appointed personal physician to the King of Portugal. *Alfonsus magnus* could be Alfonso X of Castile (1221–1273). *Magister Alfonsus* is Alfonso de Valladolid, i.e. Abner de Burgos (d. 1350), a converted Jew, then sacristan of Valladolid (= "*converso sacrista [Vallis]toletano*"), who served as an interpreter from Arabic to Spanish to Alfonso Dinis, when the latter was writing the Latin version of Averroes' *De separatione primi principii*. So, in the passage quoted above, this is Abner de Burgos, who was the eyewitness to Averroes' *Almagesti abbreviatum*, and certified that a (Hebrew or Latin?) translation was made at Alfonso the Great's request. Since Averroes' *Epitome* contains no table and little numerical data, it would be worth seeing whether the generalizing nature of these texts results from an interference or a coincidence.

The *Almagesti minor* is indisputably an important milestone in the history of astronomy. Henry Zepeda has provided an excellent piece of scholarship that deserves to be known by all those who are curious about medieval and Renaissance astronomy.

References

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Steel, C., and Guldentops, G., 1997. An unknown treatise of Averroes against the Avicennians on the first cause. *Recherches de Théologie et Philosophie Médiévales*, 64, 86–135.

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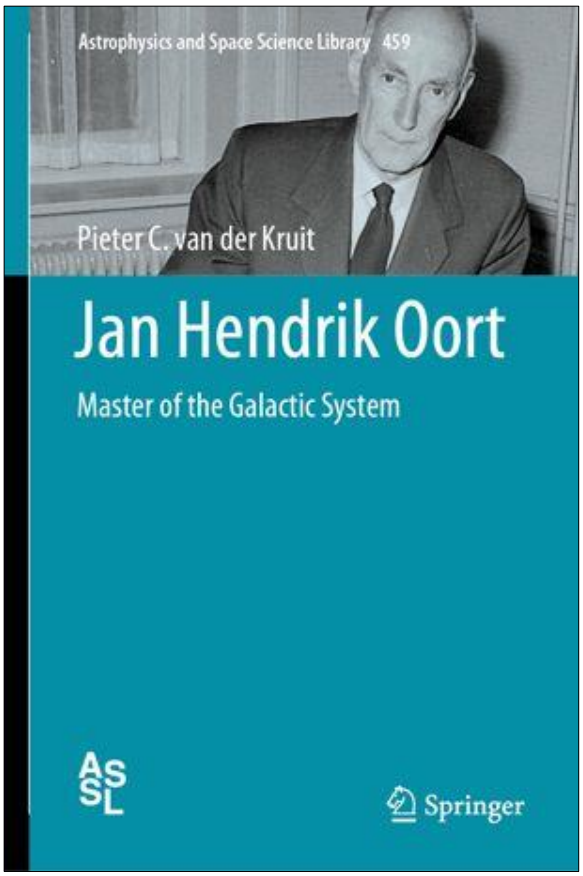
***Jan Hendrik Oort: Master of the Galactic System*, by Pieter C. van der Kruit (Cham (Switzerland), Springer, 2019). Pp. xx + 726. ISBN 978-3-030-17800-0 (hardback), 160 × 240 mm, €155.99.**

The very slender Jan H. Oort (1900–1992) was one of the colossi of twentieth century astronomy and well deserves a colossal biography. This he now has, thanks to his student, Pieter C. van der Kruit (PhD, Leiden, 1971).[1] This volume does not tell you everything that is to be known about Oort (one of my own stories appears near the end of this review), but it does present an enormous richness of information about his life, work, influence on other scientists, and contributions to the survival of international astronomy under exceedingly difficult circumstances. Van der Kruit, himself an outstanding research astronomer,[2] only nominally retired, also provides interludes of explanation of the scientific issues as seen then and now surrounding Oort's achievements, particularly concerning the structure and dynamics of our own Milky Way Galaxy and some of its wondrous contents.

The last 100 pages include a CV, list of publications, students, honours, and academic ancestors; English language versions of Oort's inaugural and valedictory addresses as Professor



at Leiden (1935 and 1970); as well as the talk he gave at the post-WWII re-opening of Leiden Sterrewacht (Observatory) on 20 June 1945; notes citing sources; and Indices of people, galaxies, telescopes, places, and concepts. The directly-quoted words of Oort and everybody else, written or spoken, appear in a distinctive bold-face type, which is genuinely very helpful in keeping the reader from worrying, "Is this just the opinion of the author, or someone else?"

Why should anybody care, always excepting, as for all biographies, family and friends (among the latter of whom I am proud to count myself)? Some indication of Oort's significance for twentieth century astronomy is to be found in

the eponyms. There is an Oort Cloud of potential future comets lurking around the outside of the Solar System. The Oort Constants A and B describe the rotation of the disk of our Galaxy (of which rotation he was co-discoverer). An Oort Limit pertains to speeds of stars that are part of that disk versus denizens of a non-rotating halo. Another Oort Limit on the density of stuff in the galactic disk put an early constraint on the possibility of a local component of dark matter. The Oort-Spitzer mechanism stirs up interstellar gas, so that it hadn't all collapsed into stars long before our Solar System formed. And don't forget the Oort-Lindblad third integral. Never mind if you haven't heard of the first two—they won't be in the exam (because Oort didn't set it). One and two have to do with conserved quantities of energy and angular momentum in a system of very many interacting point masses, like the stars of the Galactic disk. And the third integral concerns motions of stars perpendicular to that disk. Since Bertil Lindblad (1895–1965) and Oort were collaborators, this is the place to mentions 'Lindblad's Law'—that an astronomer ends up living where his wife was born. Oort was a prime example of this; offered at various times professorships and other positions in the United States, he gave the deciding vote to his wife, Johanna Maria Graadt von Rogeen, called Mieke (1906–1993; married 1927). She had no desire to live anyplace other than in The Netherlands, although they visited many other places.

We of later generations are likely to associate Oort primarily with the kinematics and dynamics of stars in the Milky Way, citing papers with titles like "Observational evidence confirming Lindblad's hypothesis of a rotation of the Galactic System", and "The force exerted by the stellar system in the direction perpendicular to the Galactic plane and some related problems", with, perhaps, a faint memory that his 1926 Groningen PhD thesis (begun under Jacobus C. Kapteyn and completed with Pieter van Rhijn) was titled "The Stars of High Velocity". Oort and colleague Theodore Walraven (1916–2008) were the first to map the polarisation of the Crab Nebula supernova remnant, the definitive study being carried out in turn by Oort's Leiden student Lodewijk Woltjer (1930–2019). The mature Oort expanded his horizons from the Milky Way Galaxy to clusters and superclusters of galaxies and the whole Universe, while also looking inwards, towards the center of our Galaxy, and collecting and summarising evidence that he thought supported some remarkable sort of activity going on in the core (now definitely associated with a central black hole of about four million solar masses, although Oort never quite endorsed this).

Nevertheless, writes van der Kruit,

> Among the people I consulted, there is a clear consensus that Oort's most important contribution to astronomy has been in the realization of the potential of radio waves for the study of the Galaxy and his subsequent efforts leading up to the work at Kootwijk. (page 476).

This is the site of the first Dutch radio observatory, and its successor, the Westerbork Synthesis Radio Telescope (WSRT) has been a significant research instrument right through to the present day.

Pieter van der Kruit's book is organised in roughly chronological order, from biological ancestors, including a number of theologians and clergymen, through to grandchildren. One of Oort's grandsons, Marc J.N. Anton Oort, defended his PhD in Astronomy at Leiden in 1987, enabling his grandfather to be a member of the examining faculty. He addressed Marc as "the candidate", preserving one of the fine traditions of the Dutch PhD exam, in which the student begins the process as "honourable candidate" and, if all goes well, ends it as "learned friend". Another Leiden PhD., Gart Westerhout (1927–2012), influenced by Oort although H.C. van de Hulst's student (page 632), brought some of these customs to the University of Maryland, where he was for a time the Astronomy program director. His thesis was on radio astronomy.

The Oort biography features no fewer than 326 figures and, like the Indices, these include people, places, telescopes and astronomical concepts. Fifteen of the chapters begin with drawings, paintings or photographs of Jan Oort from the time covered by the chapter. The reference footnotes are numbered consecutively though the volume, a true blessing to the scrupulous reader, when both the footnotes and the chapters are many! The book's subtitle, *Master of the Galactic System*, comes from the remarks made by Henry Plaskett (1893–1980, the Canadian born Professor at Oxford and President of the Royal Astronomical Society 1944–1947) when presenting the 1946 RAS Gold Medal to Oort. Plaskett said: "… the Galactic System seems at last to have met its master in the thoroughness of our Medallist, working quietly and thoughtfully in his room at Leiden." (page 2). In fact, though, the Oorts had spent most of 1943–1945 at a country house,[3] variously shared with family, friends and colleagues, during the period that German occupation made life both dangerous and precarious for much of the Dutch population.

Oort was always distinctly both athletic and slender, for instance coxing a rowing team in 1918, and he mentions in a 1918 letter to his brother being "… hungry all day, like most people here." (page 42, in Groningen; The Netherlands was neutral in WWI but nevertheless was affect-

ed by a European-wide shortage of food). He was an enthusiastic walker and cyclist (necessary forms of transportation at many times and places in his life) and ice-skater, using a skate type called a Friese doorloper, just a wooden frame with a steel blade underneath, turned up at the toe, that was tied to sturdy boots or shoes with leather straps (pp. 335–336). Between 1909 and 1997 there were 15 formal 'Eleven Cities (skating) Tours'. Held only when the ice was strong enough to support thousands of competitive racers and tourists. Nearly 200 km in length, the tour "… started in Leeuwarden, went past all the historical Friesian towns with medieval city rights, before returning to Leeuwarden." (pages 2–3). The winters of 1940–1942 were particularly cold. Oort skated most of the Tours of 1940 and 1941, but in 1942, with the temperature 15° below zero, he wrote:

> I gave up my plan at the last moment as I do not feel fit enough to make it and my weight is so low now (55 kg)[4] that I will need extra food." (page 336).

But worse was to come in the winter of 1944–1945, when the German occupiers pulled back both food and transport lest these fall into the hands of the advancing Allied Forces. Oort mentions cycling long distances to get potatoes for his family and neighbors (pages 360ff). The 'default option' was tulip bulbs and sugar beets, which Oort apparently found less revolting than did some of his fellow-countrymen.

Among the lingering effects of that famine were the death of Oort's astronomical colleague Jan Woltjer Jr, in January 1946; the half-day work at the Sterrewacht by the under-nourished staff when it re-opened in June 1945; and an emaciated Oort at the time of his first post-war visit to England, in September 1945, as part of the process of re-establishing the structure of the International Astronomical Union (IAU), of which he had been General Secretary since 1938 (Blaauw, 1994: 137).

These few pages cannot possibly do justice to the 726 pages that Pieter van der Kruit has provided, but many parts of the story have happy endings. For example, the IAU and the European Southern Observatory that Oort so strongly supported are both in good condition, and Dutch radio astronomers have just become collaborators with Chinese colleagues in operating a radio telescope from the far side of the Moon.[5] And despite the negative-sounding propositions included (as part of Dutch tradition) in the theses of Oort, and his students Lodewijk Woltjer, Maarten Schmidt and van der Kruit himself, they all landed good jobs and their research papers continue to be cited.[6]

It is the custom in such reviews as these to draw attention to a few errors in the book under consideration. Nominally, the process is supposed to keep readers (of whom I hope there will be many, especially of the book, but also of this review) from being misled. The real purpose, of course, is to demonstrate that 'Even Homer nods', and that the reviewer has looked hard at lots of pages. So, here is my short list:

- The 1970f paper said to be about Crab Nebula polarisation is actually about galaxy formation.
- Martin Schwarzschild is said to have been Jewish (page 449), but our 'tribe' is a matrilineal one, and while Karl was Jewish his wife was not.
- The mention on page 490 of the Alpher-Gamow big bang explanation of the synthesis of the chemical elements leaves the impression that Hans Bethe actually participated in this work, rather than having been added *in absentia* to turn 'alpha-gamma' into 'alpha-beta-gamma'.
- On page 491 Nancy Grace Roman is given sole credit for demonstrating that 'weak-lined' stars were generally of high velocity. In fact, Wilhelmina Iwanowska (Torun) and Martin Schwarzschild found the same result at the same time.
- Oort's student Lodewijk Woltjer is described on page 522 as *working* at Columbia, when he actually was Departmental Chair, Rutherford Professor, and Director of the Observatory.
- On page 318 galaxies NGC 4494 and 4495 are confused, merged, or typo-graphed.
- And my favourite: van der Kruit expresses surprise and puzzlement (as perhaps Oort did himself at first) that Oort was taken to something called the Egyptian Theatre in 1922. But so it was. The first of Sid Grauman's motion picture palaces, the Egyptian, opened shortly before Grauman's Chinese (where hand and foot impressions fill the courtyard), and the Egyptian was the first to host a premiere of a film as a major event.
- There is also mild confusion on page 127 about prohibition and abolition, but only the former was in effect in the USA when Oort was first there.
- There is also a little confusion (see page 529) about the various types of supernovae, their parent populations, and physical processes.

This leaves only *my* Oort story, and a few footnotes. It must have been in February 1968 when Oort paid another of his visits to Pasadena, the California Institute of Technology, and Mt. Wilson Observatory. My PhD dissertation, titled *Motions and Structure of the Filamentary Envelope of the Crab Nebula*, was essentially complete, but in the process of being typed by a

professional stenographer, error free, and on special paper suitable for microfilming. My super-visor was Guido Munch, who knew Oort but does not make the Index in van der Kruit's book,[7] and he asked Oort to take a look at my thesis and provide advice and criticism.

There is no doubt that Oort carefully read my version, typed on a Smith-Corona portable typewriter with italic typeface on ordinary paper and not yet error free, for, a few days later, he came to the Caltech office I shared with a couple of other female astronomy graduate students, sat down next to my desk, and pulled out several sheets of pale blue paper, written on in only slightly less pale blue ink, in the tiny hand-writing reproduced in several places in van der Kruit's biography (e,g. see pages 636–637). He started at the top, I suppose, phrasing criticisms and advice as questions, which I did my best to answer or otherwise respond to. And I kept trying to catch a glimpse of the blue paper to see what might be coming next. Unfortunately, his notes were in Dutch. This is really the end of the story, but here is how it all played out, in case you are wondering.

I made some hasty changes to the pages already with the typist, and all went well: I de-fended on Monday 15 April 1968, the required three weeks after official copies of the properly typed text had been given to the committee members, and was declared to be entitled to be called Dr Trimble.

The first paper from my thesis was sub-mitted on 1 May 1968 to the *Astronomical Jour-nal*, then under the editorship of Oor'ts student, Lodewijk Woltjer. It duly thanked Oort amongst others. The paper was refereed by Otto Heck-mann, the first Director General (DG) of the Eu-ropean Southern Observatory, for which Oort had been one of the prime movers. Woltjer was the third DG (calendar years 1975–1987). Their order as Presidents of the IAU was: Oort (1958–1961), Heckmann (1967–1970) and Woltjer (1994–1997). In between as DG of ESO (1970–1974) and IAU President (1976–1979) came Adriaan Blaauw, who has written books on the histories of both institutions (Blauuw, 1991; 1994). That first thesis paper does not cite Oort's work on the Crab Nebula, but the second paper does. In February 1970 it was submitted to the *AJ* (still under Woltjer's edit-orship), and was published in October 1970. The referee on this occasion was Rudolf Min-kowski, whose work was cited in paper 1. Both papers cite work by Munch and by Woltjer. I think that we must all have been rather inbred in those days!

Notes

1. Pieter van der Kruit is also the author of a biography of Oort's "mijn inspireer-enden leermeester" Jacobus Cornelius Kapteyn, (van der Kruit, 2015) and he has established and maintains the following Oort web site: www.astro.rug.nl/JHOort
2. For example, he found that our own Solar System oscillates back and forth only about 85 pc perpendicular to the Galactic plane, compared to about 340 pc in and out of an average circular orbit and 480 pc ahead and behind its average motion around the Galactic centre (see page 217).
3. The move from Leiden to the countryside in 1943 was accompanied by 19 crates and suitcases, 10 bags of anthracite coal (presumably for heating, since cooking was done on a wood stove) and the piano. Oort's children were 13, 11 and 8 years old at the time.
4. That is 123 lbs for us unmetrified 'primitives'.
5. This was announced in a press release issu-ed on 27 November 2019.
6. Special thanks to Pieter van der Kruit for providing me with English translations of these propositions from Woltjer's and his own theses, and for Oort's ones in the book. I struggled through Schmidt's on my own, including the one that deals with traffic right-of-ways on roundabouts!
7. Curiously, I do make the Index, though only for having written about the April 1920 Curtis-Shapley debate. This took place while Oort was an undergraduate student, and he said later he had always thought that there were other galaxies (Curtis' point) and that the Solar System was not at the center of our Milky Way Galaxy (Shapley's point).

Referenecs

Blaauw, A., 1991. *ESO's Early History: The Euro-pean Southern Observatory from Concept to Reality*. Garcing-bei-Munche, European Southern Obser-vatory [My copy is inscribed: "To Virginia Trimble, with best wishes, Adriaan Blaauw, May 2000."]

Blaauw, A., 1994. *History of the IAU: The Birth and First Half-Century of the International Astronomical Union*. Dordrecht, Kluwer. [My copy was again a gift from the author, but what is written inside the fly leaf is a correction of the name of an astronomer mentioned on page 59: "Frederick not Frank Seares".]

van der Kruit, P., 2015. *Jacobus Cornelius Kapteyn: Born Investigator of the Heavens.* Cham (Switz-erland), Springer.

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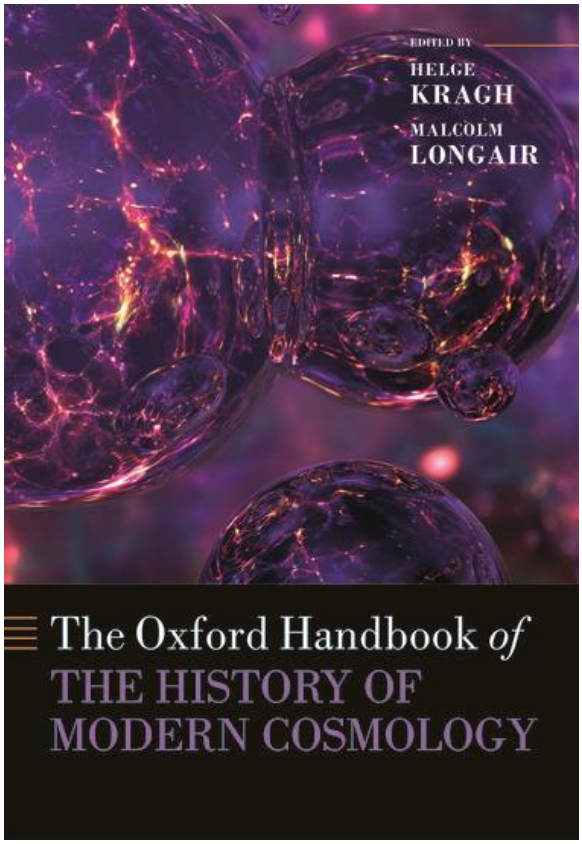
***The Oxford Handbook of the History of Modern Cosmology*, edited by Helge Kragh and Malcolm S. Longair (Oxford, Oxford University Press, 2019). Pp. xvii + 608. ISBN 978-0-19-881766-6 (hardback), 175 × 252 mm, €110.**

Although I may have published a paper on the origin of the dark matter concept, in collaboration with Australian colleagues (Montgomery et al., 2009), cosmology is certainly not my research forté. But if I wanted to start researching this field, or if someone asked me to recommend a book that provides a succinct but up-to-date overview of "… how our present understanding of the universe has emerged through a long and complex series of investigations with roots back in the nineteenth century and even earlier." (page v), I could do no better that direct them to this new book edited by Helge Kragh and Malcolm Longair. Both are now Emeritus



Professors, and Helge will be well known to our readers through papers he has published in this journal (see Kragh, 2012; 2017; Pedersen and Kragh, 2008).

Denmark's Helge Kragh penned two of the books 13 chapter, while Britain's Malcolm Longair wrote three solo chapters and shared a fourth with the Canadian Chris Smeenk. Associate Professor Smeenk also wrote the final chapter, while other authors of individual chapters are fellow Canadian Professor Robert W. Smith (the latest recipient of the LeRoy E. Doggett Prize from the Historical Astronomy Division of the American Astronomical Society), the Dutch-based Italian Dr Matteo Realdi, Spain's Dr Silvia De Bianchi, Serbia's Professor Milan Ćirković and America's Emeritus Professor Bruce Partridge. It is interesting to note that only Longair, Ćirković and Partridge are astronomers; the other authors are historians of science. It is also illuminating that only one of the eight is female (12.5%). It is lucky that this is not an IAU-sanctioned book since it would likely not be approved given this conspicuous gender imbalance!

Be that as it may, the 13 chapters in this book range from pre-Einstein and non-Einstein cosmology (by Helge Kragh in Chapter 1) through to Chapter 13 (by Chris Smeenk) on philosophical aspects of cosmology. Along the way, there are four chapters on various cosmological models (by Robert Smith, Matteo Realdi and Helge Kragh), while two excellent chapters by Malcoln Longair that span observational and astrophysical cosmology from 1940 to 2018, a chapter on the cosmic microwave background by Bruce Partridge, and a chapter by Longair and Smeenk on inflation, dark matter and dark energy collectively provide an excellent overview of recent developments in observational cosmology. In Chapter 9, Silvia De Bianchi discusses cosmology research during the 'Cold War', and in the penultimate chapter Milan Ćirković takes us into the fascinating field of multiverses, string theory and other concepts that not so long ago were regarded as nothing more than science fiction.

The length of the chapters in this book range from 32 pages to 54 pages, and most are well illustrated (with Longair's 1940–1980 and 1980–2018 chapters containing the greatest numbers of figures, at 20 and 21 respectively). All chapters are accompanied by notes and references, ranging from just half a page in the case of one of Longair's chapters to typically 4 or 5 pages for most other chapters. Meanwhile, the number of numbered equations varies from zero in Robert Smith's chapter, to >18 in chapters by Helge Kragh (two of them) and Malcolm Longair (three of them). There seems to be no overall correlation between chapter length, the number of figures and the number of equations.

Rounding out this book are 61 pages of References—an invaluable resource for anyone wanting to read up on any of the topics of the 13 chapters—followed by Subject and Author Indices.

All in all this is a splendid book that does indeed take you on a tour of "The history of modern cosmology", just as the title suggests. The chapters are all written by experts and for the most part are easy reading, with added