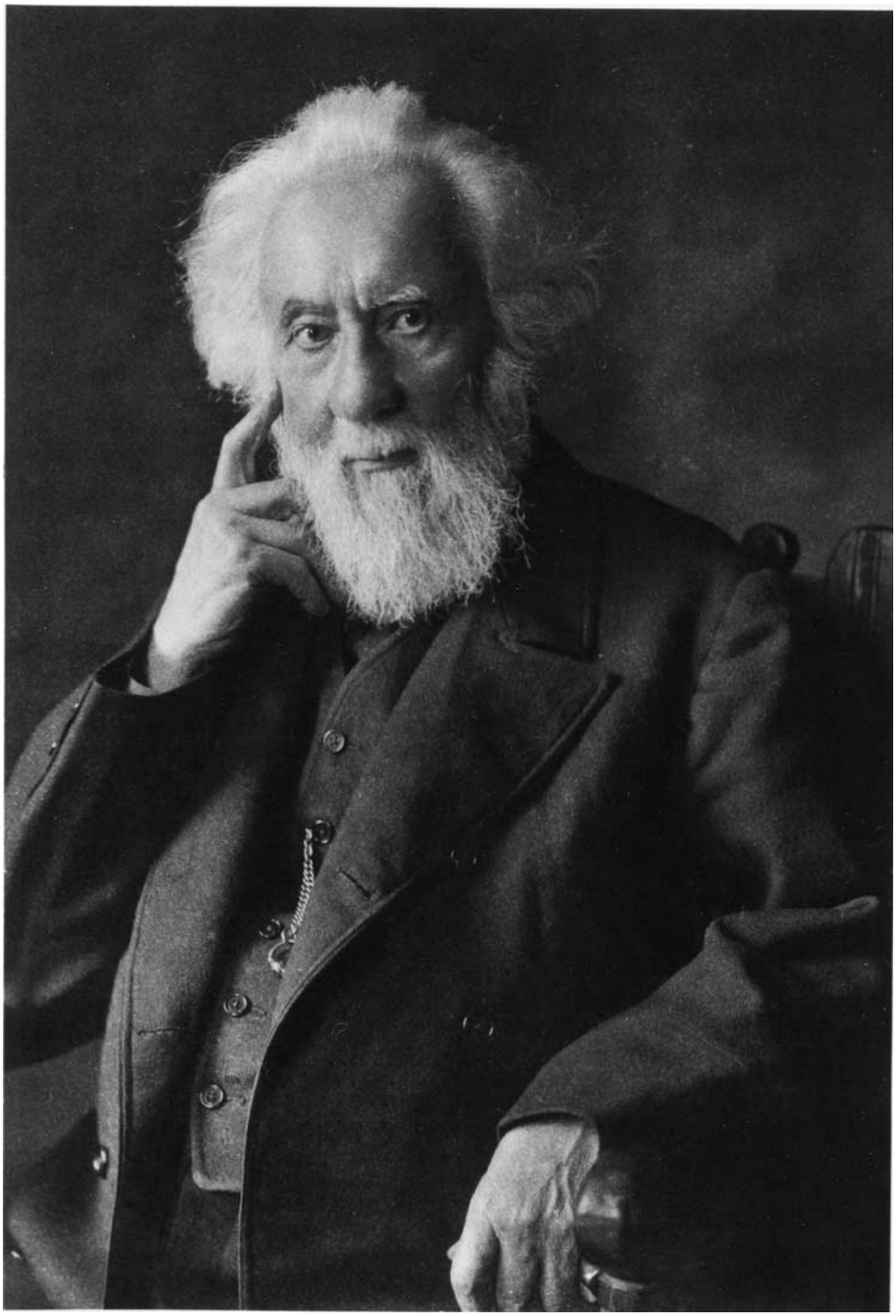
UNRAVELLING STARLIGHT

Challenging traditional accounts of the origins of astrophysics, this book presents the first scholarly biography of nineteenth-century English amateur astronomer William Huggins (1824–1910). A pioneer in adapting the spectroscope to new astronomical purposes, William Huggins rose to scientific prominence in London and transformed professional astronomy to become a principal founder of the new science of astrophysics. The author re-examines his life and career, exploring unpublished notebooks, correspondence, and research projects to expose the boldness of this scientific entrepreneur. While Sir William Huggins is the main focus of the book, the involvement of Lady Margaret Lindsay Huggins (1848–1915) in her husband's research is examined, where it may have been previously overlooked or obscured. Written in an engaging style, this book has broad appeal and will be valuable to scientists, students, and to anyone interested in the history of astronomy.

BARBARA BECKER taught history of science at the University of California, Irvine, until her recent retirement. A leading authority on William Huggins, her research interests also include the role of amateurs in the development of nineteenth-century professional astronomy, and the role of controversy in shaping the substance and structure of scientific knowledge.



Sir William Huggins, c. 1905. (*PRS* **86A**)

UNRAVELLING STARLIGHT

William and Margaret Huggins and the Rise of the New Astronomy

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For Madge

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Acknowledgements

This book grew out of my dissertation, 'Eclecticism, Opportunism, and the Evolution of a New Research Agenda: William and Margaret Huggins and the Origins of Astrophysics' (The Johns Hopkins University, 1993). I still feel the great debt I owe all who helped bring that work to life, particularly to Robert Smith, Peter Hingley and the late Maire Brück, individuals whose encouragement kept me poking around and scribbling over the years.

It was Robert who, back in 1988, first urged me to pursue my interest in investigating William Huggins's role in the origins of astrophysics. After I completed my graduate work, he continued to serve as mentor and friendly nudge. His scholarship, his breadth and depth of knowledge, his clarity of thought and expression, his incredible memory and attention to detail, his wit, his gentility, and above all his candor and honesty have been an endless source of inspiration for me in my teaching, research and writing.

Peter has taken an avid and active interest in my research from the very beginning. Sitting squarely in the midst of a modern information crossroads, he keeps his attentive and discerning ear to the ground and is generous in keeping scholars abreast of what he hears. Without his enthusiastic intercession on behalf of my manuscript, it would still be filed away out of public view.

I deeply regret being unable to complete this work in time for Maire to see it in print. She was so full of ideas and energy that I foolishly imagined she would always be here. We began our wonderful long-distance conversation in May 1991. The wealth of information she had ready at her fingertips (and floating around on the ends of her cranial neurons) never ceased to amaze me. Her warm generosity in sharing all she knew inspired me to do the same at every opportunity. Whenever I became overwhelmed or disheartened by the task that lay ahead, her letters spurred me on. At each step, she led the way by her own example. It was a joy and a privilege to call her my friend. *Ar dheis Dé go raibh sí.*

Now, over two decades after embarking on my journey, I have a multitude of new debts to declare. Much of my research for the present work was made possible thanks to the kind assistance and dedication of the librarians and staff who both maintain the archival material in their collections and facilitate scholars' access to them. Throughout the years, each of my many questions and requests received a cheerful response from this lively corps of hard-working individuals who know and understand the value of the treasures they keep. In particular, I would like to thank Peter Hingley (Royal Astronomical Society Library); Adam Perkins and Zoe Rees (Cambridge University Library, Manuscripts Room); Rupert Baker,

Joanna Corden and Clara Anderson (Royal Society Library); Dan Lewis (Huntington Library); Gregory Shelton (US Naval Observatory Library); Ruth Rogers and Mariana Oller (Wellesley College Library, Special Collections); Mark Hurn (Cambridge University, Institute of Astronomy Library), April Brewer (University of North Carolina, Wilson Library, Rare Book Collection); and Elizabeth Campbell and Melinda McIntosh (University of Massachusetts, Amherst, W. E. B. DuBois Library).

To complement the archival material, my research required direct access to hard-to-locate nineteenth- and early twentieth-century journals, books and other documents. I had already transcribed and photocopied much of what I needed years ago from volumes on the library shelves at Hopkins and the US Naval Observatory, or obtained through interlibrary loan. But the advent of the internet and digitisation of print material brought fully searchable copies of all these resources – and more – to my fingertips whenever I needed them. I (like many other scholars) am extremely grateful for the efforts of everyone responsible for the SAO/NASA Astrophysics Data System (ADS), a Digital Library portal operated by the Smithsonian Astrophysical Observatory (SAO) under a NASA grant and hosted by the High Energy Astrophysics Division of the Harvard-Smithsonian Center for Astrophysics. I also wish to acknowledge my debt to the libraries and other institutions around the globe that have contributed to the growing online availability of books and journals under the aegis of groups like Project Gutenberg, Google Books, Internet Archive and Gallica.

No scholar or her work can thrive in isolation. I am indebted to Helena Pycior, Michael Hoskin, Bernard Lightman, Karl Hufbauer, Michael Crowe, Matt Dowd, David DeVorkin, Peggy Kidwell, Joe Tenn, Wayne Orchiston, Falk Rieß, Tom Williams, the Royal Astronomical Society, the Astronomical Society of the Pacific, the California Academy of Sciences, the Historical Astronomy Division of the American Astronomical Society, the biennial History of Astronomy Workshops and the History of Science Society for the opportunities they have given me to share, discuss and refine my work over the years.

I extend heartfelt thanks to the many people – some friends, others complete strangers – who thoughtfully responded to my queries when my own expertise was inadequate to process the information at hand. John McMahon translated Latin phrases on the title page of William Huggins's first observatory notebook. The page's Hebrew inscription was translated and transliterated by Dan Schroeter. Alan Dehmer's mastery of the art and craft of nineteenth-century photographic techniques and methods enabled me to decipher and interpret barely legible handwritten notes on the subject with greater confidence. Jürgen Teichmann clarified the complex chronology of Joseph von Fraunhofer's employment and responsibilities at the Optical Institute in Benediktbeuern and generously provided me with copies of essential but otherwise inaccessible reference material. Robin Mason and Marilyn Morgan shared valuable information on the casting of Mt Wilson's 100-in glass disc. Art Champagne helped me look at the Hugginses' spectroscopic investigation of the radium glow with modern eyes. David Dewhirst linked me in a very personal way to William Huggins and his Great Grubb telescope through his firsthand account of using the instrument more than a half century ago at Cambridge's Institute of Astronomy.

Space does not permit me to enumerate my many obligations to Jim Bennett, Allan Chapman, Ian Elliott, Owen Gingerich, Ian Glass, the late Owen Hannaway, Peter Harman and Simon Schaffer. Suffice it to say that, without their knowledgeable guidance, kind

assistance and encouragement I would still be wandering in Dante's 'dark wood'. Special thanks to Richard G. French for his personal interest in my work over the years. He is currently overseeing a major renovation of Wellesley College's Whitin Observatory which promises to modernise its instructional operations while restoring its historical beauty. Particularly exciting is the planned restoration and reinstallation of three stained glass windows given to the Observatory by Margaret Huggins in 1914. I am deeply grateful to Dick for his kind permission to use an image of the panel 'Sun with Chromosphere, a Nebula, & other Figures' on the cover of this book. I remember the moment I first saw this extraordinary window. It required quite an effort to remove it from the drawer in the observatory where it had been stored for many years. I had seen a black-and-white photograph of the window, but was totally unprepared for the powerful impact of its vivid colour and exquisite design. It took my breath away.

Most of the illustrations in this book were scanned by me from the volumes in which they originally appeared. One of these figures deserves special mention (see Figure 4.6). It is a reproduction of the frontispiece of William Huggins's booklet *On the Results of Spectrum Analysis Applied to the Heavenly Bodies* (1866) from the library of the late Gerald James Whitrow, FRAS (1912–2000). I was honoured to receive this small book as a gift in 2001 from Professor Whitrow's widow, Magda, through Peter Hingley's thoughtful agency. All of the book's illustrations are original photographs pasted neatly in place. They have faded over the years, of course. Readers wishing to see the details of the spectral map depicted in the frontispiece will find it reproduced more clearly elsewhere (see, for example, Huggins and Miller, *PTRSL* **154**, Plate XI; Huggins and Huggins, *Scientific Papers*, opposite p. 60). I wished to include a copy of this historic image in my own book both as a tribute to Professor Whitrow memory and to express my sincere gratitude to all responsible for the gift.

Other important historic images are included in this book thanks to the efforts and generosity of the following individuals and institutions. A portrait of William Huggins near the beginning of his long career (see Figure 2.1) appears in this volume with the kind permission of the Royal Astronomical Society and Photo Researchers, Inc. Mariana Oller scanned pages from the Tulse Hill Observatory notebooks, portions of which are reproduced in this volume with the kind permission of Wellesley College Library's Special Collections (see Figures 3.1, 3.3, 3.4, 4.1, 6.1, 6.3a, 7.2, 7.3, 7.4, 10.5, 10.6 and 12.3). Gregory Shelton successfully scanned the delicate – and difficult to capture – image of the nebula surrounding η Argus [Carinae] drawn by John Herschel and reproduced on Plate IX of his *Results of Astronomical Observations made ... at the Cape of Good Hope* (1847). The image is reproduced here (see Figure 5.1) courtesy of the US Naval Observatory Library. Imaging Services of the Cambridge University Library scanned an illustrated page from a letter written by William Huggins to George Gabriel Stokes (Add MS 7656.H1168, 2 January 1882). It is reproduced here (see Figure 11.2) by kind permission of the Syndics of Cambridge University Library. Ian Glass generously sent me an historic photograph which shows the coronagraph built by Howard Grubb and used by David Gill at the Cape Observatory to take routine photographs of the solar corona without an eclipse using William Huggins's prescribed method. It is reproduced here (see Figure 11.4) courtesy of the South African Astronomical Observatory.

I wish to thank my colleagues and students in the History Department of the University of California, Irvine, for their support and encouragement for my research. It was truly a privilege to be part of such an intellectually stimulating community of scholars. I am particularly grateful to Marc Kanda who kept my access to campus resources active after my retirement. Special thanks to Ingrid Wilkerson and Kim Weiss for sharing their infectious curiosity. Such restless itches (I hope) will never be satisfied.

Finally, a few, albeit inadequate, words of appreciation to my friends and family. Despite her distance, Gillian Wu continues to be an example, an anchor and a cheering fount of unbridled enthusiasm. Louis Carlat's youthful blend of humour and sagacity has kept my thoughts focused and my nose to the grindstone. Thanks to my brother, Pat, for his genealogical research assistance and for helping me locate copies of relevant letters from the Henry Draper papers at the New York Public Library. My daughter, Misha, all the while juggling the demands of motherhood and career, eased my transition to the academic world in Chapel Hill by toting books on arcane subjects from and to the university's various libraries for my use. My son, Aaron, now a father himself, interrupted his busy schedule to venture gamely into the bowels of the microfilm room of UMass, Amherst's DuBois Library to copy pages I had missed in the Hale papers. Their delightful spouses, meanwhile, have come to accept (I think) a pixilated mother-in-law whose head appears to be hopelessly trapped in the nineteenth century. The newest stars in my constellation – granddaughters Olivia, Josephine and Lyra – never cease to energise me and light my path. My best friend and loving husband and I have shared more than four decades together, half of which have been spent co-habiting with the Hugginses! In all that time, Hank has never begrudged their presence. Instead, he has provided me with untiring support for all that I set out to do. Whenever computer glitches halted my progress, he dropped whatever he was doing and calmly came to the rescue. He eagerly stepped into his new role of grandfather to allow me precious time to complete my manuscript. When chapters emerged, his cogent comments and suggestions helped me to see what I had written afresh. Now, as I prepare to resume life in the twenty-first century (already in progress), the doors and windows he has opened make it possible for me to hear the sweet Carolina air resound with strains of bluegrass and children's laughter.

Chapel Hill
North Carolina
12 May 2010

Abbreviations

Journals

AA:	*Astronomy and Astrophysics*
AC:	*Annales de Chimie*
ACP:	*Annales de Chimie et de Physique*
ADB:	*Australian Dictionary of Biography*
AJ:	*Astronomical Journal*
AJP:	*American Journal of Physics*
AJS:	*American Journal of Science*
AJSA:	*American Journal of Science and the Arts*
AN:	*Astronomische Nachricten*
AP:	*Annalen der Physik*
APC:	*Annalen der Physik und Chemie*
APJ:	*Astrophysical Journal*
AR:	*Astronomical Register*
BJHS:	*British Journal for the History of Science*
BJP:	*British Journal of Photography*
CM:	*Cornhill Magazine*
CR:	*Comptes Rendus Hebdomadaires des Séances de l'Académie des Sciences*
DNB:	*Dictionary of National Biography*
DSB:	*Dictionary of Scientific Biography*
EJS:	*Edinburgh Journal of Science*
EM:	*English Mechanic*
EPJ:	*Edinburgh Philosophical Journal*
ER:	*Edinburgh Review*
IAJ:	*Irish Astronomical Journal*
IO:	*Intellectual Observer*
JAD:	*Journal of Astronomical Data*
JAHH:	*Journal of Astronomical History and Heritage*
JBAA:	*Journal of the British Astronomical Association*
JHA:	*Journal for the History of Astronomy*
JRASC:	*Journal of the Royal Astronomical Society of Canada*

MLPSM: *Memoirs of the Literary and Philosophical Society of Manchester*
MNRAS: *Monthly Notices of the Royal Astronomical Society*
NRRSL: *Notes and Records of the Royal Society of London*
OBS: *Observatory*
PA: *Popular Astronomy*
PANSP: *Proceedings of the Academy of Natural Sciences of Philadelphia*
PASA: *Proceedings of the Astronomical Society of Australia*
PASP: *Publications of the Astronomical Society of the Pacific*
PJ: *Pharmaceutical Journal*
PM: *Philosophical Magazine*
PN: *Photographic News*
PRI: *Proceedings of the Royal Institution*
PRS: *Proceedings of the Royal Society*
PTRSL: *Philosophical Transactions of the Royal Society of London*
QJRAS: *Quarterly Journal of the Royal Astronomical Society*
QJS: *Quarterly Journal of Science*
RBAAS: *Report of the British Association for the Advancement of Science*
SM: *Sidereal Messenger*
SP: *Science Progress*
SS: *Social Studies of Science*
ST: *Sky and Telescope*
TC: *Technology and Culture*
TOS: *Transactions of the Optical Society*
TRMSL: *Transactions of the Royal Microscopical Society of London*
TRSE: *Transactions of the Royal Society of Edinburgh*

Archival sources

CIT: California Institute of Technology
- GEH: George Ellery Hale papers

CUL: Cambridge University Library
- ERP: Ernest Rutherford papers
- GGS: George Gabriel Stokes papers
- JCM: James Clerk Maxwell papers
- RGO: Royal Greenwich Observatory

DCL: Dartmouth College Library
- CAY: Charles Augustus Young papers

HLA: Huntington Library Archives

HUA: Harvard University Archives
- ECP: Edward C. Pickering papers

LO: Lick Observatory
- MLSA: Mary Lea Shane Archives
- ESH: Edward Singleton Holden papers

NYPL:	New York Public Library
	HD: Henry Draper papers
RASL:	Royal Astronomical Society Library
RSL:	Royal Society Library
	AS: Arthur Schuster papers
	JFWH: John F. W. Herschel papers
	JL: Joseph Larmor papers
SI:	Smithsonian Institution
	MAH: Museum of American History
SAAOA:	South African Astronomical Observatory Archives
	DG: David Gill papers
UEL:	University of Exeter Library
	JNL: Joseph Norman Lockyer papers
WCL/SC:	Wellesley College Library, Special Collections
YUL:	Yale University Library
	DPT: David Peck Todd papers

Organisations/institutions

BAAS:	British Association for the Advancement of Science
IUCSR:	International Union for Co-operation in Solar Research
JEC:	Joint Eclipse Committee
MIT:	Massachusetts Institute of Technology
NAS:	National Academy of Science
RAS:	Royal Astronomical Society
RS:	Royal Society