

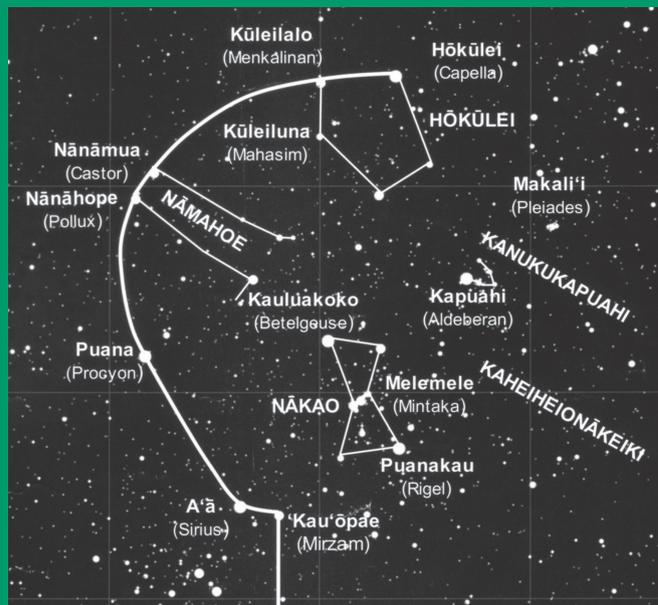
Reports on Astronomy: Commission Legacy Reports

Edited by

Thierry Montmerle

ISSN 1743-9213

International Astronomical Union



CAMBRIDGE
UNIVERSITY PRESS

REPORTS ON ASTRONOMY
TRANSACTIONS OF THE INTERNATIONAL
ASTRONOMICAL UNION VOLUME XXIXA
SPECIAL ISSUE: COMMISSION LEGACY REPORTS

COVER ILLUSTRATION

Astronomy has a considerable role in Hawaiian culture. Stars were routinely used by navigators (among other indicators like birds or swells) to steer through their transoceanic voyages across the Pacific. The figure illustrates Hawaiian asterisms and star names around Orion (document: ‘Imiloa Astronomy Center, Hilo, Hawai‘i). More information on Hawaiian star names can be found in “Nā Inoa Hōkū, Hawaiian and Pacific Star Names” (R. Kawena Johnson, J. Kaipō Mahelona, & C. Ruggles, Revised edition, Ocarina Books, Bognor Regis, West Sussex, UK, 2015).

IAU SYMPOSIUM PROCEEDINGS SERIES

Chief Editor

THIERRY MONTMERLE, IAU General Secretary

*Institut d'Astrophysique de Paris,
98bis, Bd Arago, 75014 Paris, France
montmerle@iap.fr*

Editor

PIERO BENVENUTI, IAU Assistant General Secretary

*University of Padua, Dept of Physics and Astronomy,
Vicolo dell'Osservatorio, 3, 35122 Padova, Italy
piero.benvenuti@unipd.it*

INTERNATIONAL ASTRONOMICAL UNION
UNION ASTRONOMIQUE INTERNATIONALE

International Astronomical Union



REPORTS ON ASTRONOMY

TRANSACTIONS OF THE INTERNATIONAL
ASTRONOMICAL UNION VOLUME XXIXA

SPECIAL ISSUE: COMMISSION LEGACY
REPORTS

Edited by

THIERRY MONTMERLE

General Secretary



CAMBRIDGE
UNIVERSITY PRESS

CAMBRIDGE UNIVERSITY PRESS
University Printing House, Cambridge CB2 8BS, United Kingdom
32 Avenue of the Americas, New York, NY 10013, USA
10 Stamford Road, Oakleigh, Melbourne 3166, Australia

© International Astronomical Union 2016

This book is in copyright. Subject to statutory exception and to the provisions of relevant collective licensing agreements, no reproduction of any part may take place without the written permission of the International Astronomical Union.

First published 2016

Printed in the UK by Bell & Bain, Glasgow, UK

Typeset in System L^AT_EX 2 ϵ

A catalogue record for this book is available from the British Library Library of Congress Cataloguing in Publication data

This journal issue has been printed on FSCTM-certified paper and cover board. FSC is an independent, non-governmental, not-for-profit organization established to promote the responsible management of the world's forests. Please see www.fsc.org for information.

ISBN 9781107169791 hardback
ISSN 1743-9213

Table of Contents

Preface	viii
CHAPTER I - Division A: Fundamental Astronomy	
Commission 4: Ephemerides	1
Commission 4 Working Group on <i>Standardizing Access to Ephemerides & File Format Specification</i>	22
Commission 7: Celestial Mechanics & Dynamical Astronomy	24
Commission 8: Astrometry	46
Commission 19: Rotation of the Earth.....	60
Commission 31: Time	77
CHAPTER II - Division B: Facilities, Technologies & Data Science	
Commission 5: Documentation & Astronomical Data.....	84
Commission 6: Astronomical Telegrams.....	90
Commission 14: Atomic & Molecular Data	99
Commission 14 Working Group on <i>Atomic Data</i>	103
Commission 14 Working Group on <i>Collision Processes</i>	120
Commission 14 Working Group on <i>Molecular Data</i>	137
Commission 14 Working Group on <i>Solids & Their Surfaces</i>	153
Commission 25: Astronomical Photometry & Polarimetry.....	159
Commission 40: Radio Astronomy	171
Commission 50: Protection of Existing & Potential Observatory Sites	185

CHAPTER III - Division C: Education, Outreach, & Heritage

Commission 41: History of Astronomy 196

Commission 46: Astronomy Education & Development 205

Commission 55: Communicating Astronomy with the Public 209

CHAPTER IV - Division D: High-Energy Phenomena and Fundamental Physics

Commission 44: Space & High-Energy Astrophysics 219

CHAPTER V - Division E: Sun & Heliosphere

Commission C10: Solar Activity 245

Commission C12: Solar Radiation & Structure 278

Commission C49: Interplanetary Plasma & Heliosphere 300

CHAPTER VI - Division F: Planetary Systems

Commission C15: Physical Study of Comets & Minor Planets 316

Commission C20: Positions & Motions of Minor Planets, Comets & Satellites . . 340

Commission 22: Meteors, Meteorites, & Interplanetary Dust 365

Commission 51: Bio-Astronomy 380

Commission 53: Extrasolar Planets 383

CHAPTER VII - Division G: Stars & Stellar Physics

Commission 26: Double & Multiple Stars 388

Commission 27: Variable Stars 413

Commission 29: Stellar Spectra 428

Commission 35: Stellar Constitution 436

Commission 36: Theory of Stellar Atmospheres	453
Commission 42: Close Binary Stars	474
Commission 45: Stellar Classification	490
 CHAPTER VIII - Division H: Interstellar Medium and Local Universe	
Commission 33: Structure & Dynamics of the Galactic System	495
Commission 34: Interstellar Matter	500
Commission 37: Star Clusters & Associations	502
 CHAPTER IX - Division J: Galaxies & Cosmology	
Commission 21: Galactic & Extragalactic Background Radiation	522
Commission 28: Galaxies	525
 CHAPTER X - Executive Committee	
Working Group: Women in Astronomy	531
Working Group: Public Naming of Planets & Planetary Satellites	539
Working Group: Cosmic Light (2015 International Year of Light).	549

Preface

1. A unique “Transactions” volume

The traditional IAU “Transactions A” volumes (also called *Reports on Astronomy*) compile IAU Commission and Working Groups activity reports for the triennium preceding a given General Assembly (GA), and are usually edited so as to appear a couple of months before it takes place. Normally these “triennial reports” are a tool for the Executive Committee (EC) to decide whether Commissions and Working Groups should be continued after that GA.

However, the present volume is unique in the history of the IAU, in that it concerns the 40 IAU Commissions that have all been terminated (along with their Working Groups) by the Executive Committee during the Honolulu GA (2015), as a result of a three-year long process that was triggered by the Division restructuring approved by the previous GA (see the *Transactions XXVIII B* volume: *Proceedings of the Twenty-Eighth General Assembly*, Beijing, 2012, Cambridge University Press, Ed. T. Montmerle, <http://www.iau.org/publications/iau/transactions.b/>, and http://www.iau.org/science/scientific.bodies/past_commissions/). As the same meeting, the EC approved the creation of 35 Commissions, many of them dealing with topics that were not represented in the IAU before.

These “new-generation” Commissions (<http://www.iau.org/science/scientific.bodies/commissions/>) were selected by the EC among 52 proposals upon the recommendation of two committees composed respectively of the Division Presidents, chaired by the General Secretary, and of the EC Vice-Presidents, chaired by the IAU President-Elect, Silvia Torres-Peimbert.

The resulting Division/Commission structure presents a “new IAU”, which, while in continuity with its previous structure, is more adapted to the tremendous progress in astronomy, made in particular since the creation of the Divisions was adopted at the Kyoto GA in 1997 -almost twenty years ago.

The now past Commissions had been originally created at the first IAU GA in Rome in 1922 (see the key reference book by Adriaan Blaauw: *History of the IAU: The Birth and First Half-Century of the International Astronomical Union*, Kluwer, 1994). That is why this volume is unique and has been sub-titled *Commission Legacy Reports*. More specifically:

(a) it had to be edited after the GA, in particular to include, as appropriate, the last Business Meetings of the Commissions and Working Groups (which normally appear separately after the GA in the “Transactions B” volumes);

(b) at the request of the General Secretary, many Commission Presidents accepted to enhance their reports by a historical perspective on their Commission, going back in time a couple of triennia, sometimes longer.

In that respect it is hoped that the present volume will be useful also in the context of the 100th Anniversary of the IAU (created in 1919), to be celebrated at the next GA (Vienna, 2018).

2. Contents

This volume presents reports sent by 35 Commissions, so unfortunately five reports are missing. For previous reports published in connection with the Beijing GA, the reader

is referred to the *Transactions XXVIII B* volume mentioned above, and also to earlier *Transactions B* volumes.

Note that since most of their work of the Divisions and their Steering Committees during the 2012-2015 triennium has been dedicated to the Commission reform, no report was asked from them for the present volume. However, the Proceedings of the “Division Meetings”, first introduced at the Honolulu GA and focusing mainly on their scientific activities during the 2012-2015 triennium, will appear in the *Transactions XXIX B* volume (Ed. P. Benvenuti).

The following Table gives the list of the past Commissions, in relation with their “parent” Divisions approved in Beijing.

<i>Division</i>	<i>Name</i>	<i>Commission</i>	<i>Name</i>
A	Fundamental Astronomy	C4	Ephemerides
		C7	Celestial Mechanics & Dynamical Astronomy
		C8	Astrometry
		C19	Rotation of the Earth
		C30	Radial Velocities
		C31	Time
		C52	Relativity
B	Facilities, Technologies & Data Science	C5	Documentation & Astronomical Data
		C6	Astronomical Telegrams
		C14	Atomic & Molecular Data
		C25	Astronomical Photometry & Polarimetry
		C40	Radio Astronomy
		C50	Protection of Existing & Potential Observatory Sites
C	Education, Outreach & Heritage	C41	History of Astronomy
		C46	Astronomy Education & Development
		C55	Communicating Astronomy with the Public
		C44	Space & High-Energy Astrophysics
		C10	Solar Activity
E	Sun & Heliosphere	C12	Solar Radiation & Structure
		C49	Interplanetary Plasma & Heliosphere
		C15	Physical Study of Comets & Minor Planets
F	Planetary Systems & Bioastronomy	C16	Physical Study of Planets & Satellites
		C20	Positions & Motions of Minor Planets, Comets & Satellites
		C22	Meteors, Meteorites & Interplanetary Dust
		C51	Bio-Astronomy
		C53	Extrasolar Planets
G	Stars & Stellar Physics	C26	Double & Multiple Stars
		C27	Variable Stars
		C29	Stellar Spectra
		C35	Stellar Constitution
		C36	Theory of Stellar Atmospheres
		C42	Close Binary Stars
		C45	Stellar Classification

<i>Division</i>	<i>Name</i>	<i>Commission</i>	<i>Name</i>
H	Interstellar Matter & Local Universe	C33	Structure & Dynamics of the Galactic System
		C34	Interstellar Matter
		C37	Star Clusters & Associations
J	Galaxies & Cosmology	C21	Galactic & Extragalactic Background Radiation
		C28	Galaxies
		C47	Cosmology

3. The new Commissions

For completeness, the following Table gives the list of the new Commissions created in Honolulu. (Other Commissions may be created in the future.) Note the adopted new classification, defining their relation with their “parent” Divisions approved in Beijing: (i) Regular Commissions (one parent Division); (ii) Inter-Division Commissions (with one “primary” Division and one or more “parent Divisions”); (iii) Cross-Division Commissions (with one or more “parent Divisions” on an equal basis). More details will be given in the *Transactions XXIXB* volume (see also the IAU Announcement: <http://www.iau.org/news/announcements/detail/ann15013/>).

1. Regular Commissions

<i>Division</i>	<i>Commission</i>	<i>Name</i>
A	C.A1	Astrometry
	C.A2	Rotation of the Earth
	C.A3	Fundamental Standards
B	C.B1	Computational Astrophysics
	C.B2	Data & Documentation
	C.B3	Astroinformatics & Astrostatistics
	C.B4	Radio Astronomy
	C.B5	Laboratory Astrophysics
	C.B6	Astronomical Photometry & Polarimetry
C	C.C1	Astronomy Education & Development
	C.C2	Communicating Astronomy with the Public
	C.C3	History of Astronomy
	C.C4	World Heritage and Astronomy
D	C.D1	Gravitational Wave Astrophysics
E	C.E1	Solar Radiation & Structure
	C.E2	Solar Activity
	C.E3	Solar Impact throughout the Heliosphere
F	C.F1	Meteors, Meteorites & Interplanetary Dust
	C.F2	Exoplanets & the Solar system
	C.F3	Astrobiology

1. Regular Commissions (cont'd)

<i>Division</i>	<i>Commission</i>	<i>Name</i>
G	C.G1	Binary & Multiple Star Systems
	C.G2	Massive Stars
	C.G3	Stellar Evolution
	C.G4	Pulsating Stars
	C.G5	Stellar & Planetary Atmospheres
H	C.H1	The Local Universe
	C.H2	Astrochemistry
	C.H3	Planetary Nebulae

2. Inter-Division Commissions

<i>Primary Division</i>	<i>Parent Divisions</i>	<i>Commission</i>	<i>Name</i>
A	A,F	C.A4	Celestial Mechanics & Dynamical Astronomy
B	B,C	C.B7	Protection of Existing & Potential Observatory Sites
H	G,H,J	C.H4	Stellar clusters throughout Cosmic Space & Time
J	D,G,H,J	C.J1	Galaxy Spectral Energy Distributions
J	B,H,J	C.J2	Intergalactic Medium

3. Cross-Division Commissions

<i>Parent Divisions</i>	<i>Commission</i>	<i>Name</i>
D,J	C.X1	Supermassive Black Holes, Feedback & Galaxy Evolution
A,F	C.X2	Solar System Ephemerides

4. Executive Committee Working Groups

The last section of this volume is, as usual, dedicated to Executive Committee Working Groups (EC-WG). The EC-WG “Women in Astronomy”, created during the 2003 GA in Sydney, has been renewed in Honolulu. Two other WGs, created in 2013 and 2014, respectively, address time-limited “special operations” of the IAU oriented towards the public:

(a) the EC-WG “Public Naming of Planets and Planetary Satellites”, which organized the *NameExoWorlds* contest, to engage for the first time the public, via astronomy clubs and astronomy-interested associations, to name exoplanets and their host stars after a succession of public votes; and

(b) the EC-WG “Cosmic Light”, which was created in response to UNESCO’s 2015 *International Year of Light and Light Technologies*. The corresponding report appears in the report by Division B Commission 50, which spearheaded the effort on behalf of the IAU.

Acknowledgements. I warmly thank the (past) Commission Presidents, their co-authors, and their Organizing Committees, for their hard work (in particular for the “historical context” part of their reports), and I hope the resulting volume will get the enhanced interest it deserves.

Thierry Montmerle
General Secretary (2012–2015)
 10 January 2016