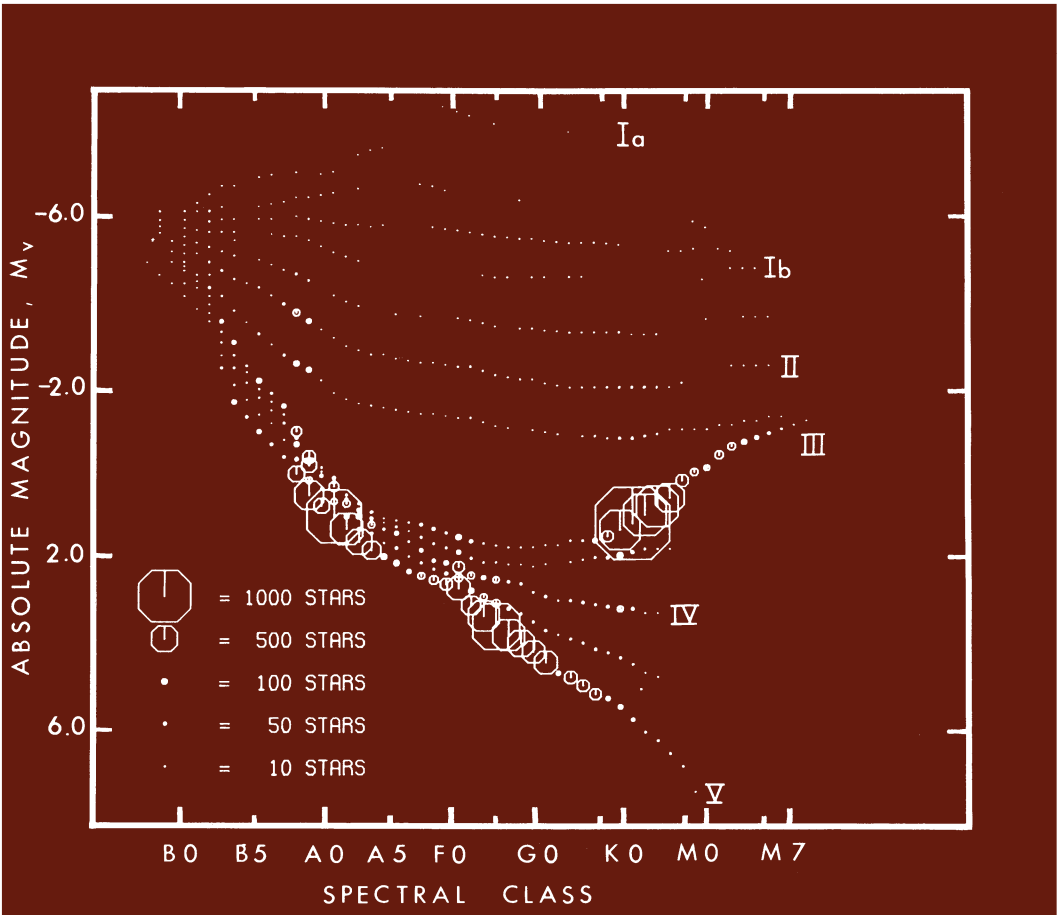


INTERNATIONAL ASTRONOMICAL UNION

SYMPOSIUM No. 80

THE HR DIAGRAM

Edited by A. G. DAVIS PHILIP and D. S. HAYES



INTERNATIONAL ASTRONOMICAL UNION

D. REIDEL PUBLISHING COMPANY / DORDRECHT : HOLLAND

BOSTON : U.S.A. / LONDON : ENGLAND

SYMPOSIUM No. 72
ABUNDANCE EFFECTS
IN CLASSIFICATION

SYMPOSIUM No. 73
STRUCTURE AND
EVOLUTION OF
CLOSE BINARY SYSTEMS

SYMPOSIUM No. 74
RADIO ASTRONOMY
AND COSMOLOGY

SYMPOSIUM No. 75
STAR FORMATION

SYMPOSIUM No. 76
PLANETARY NEBULAE

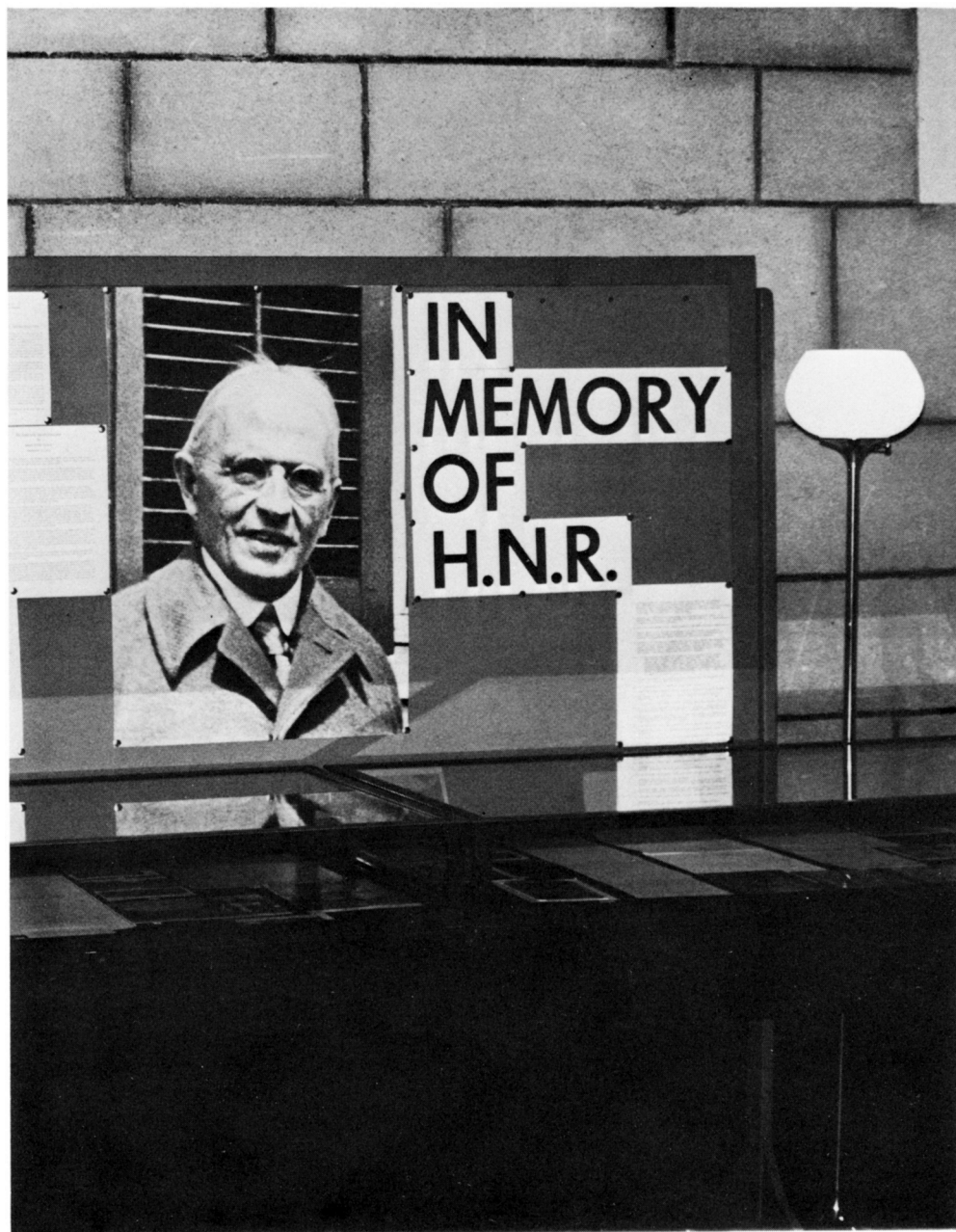
SYMPOSIUM No. 77
STRUCTURE AND
PROPERTIES OF NEARBY
GALAXIES

SYMPOSIUM No. 78
NUTATION AND THE
EARTH'S ROTATION

SYMPOSIUM No. 79
THE LARGE SCALE
STRUCTURE OF
THE UNIVERSE

D. REIDEL PUBLISHING COMPANY
DORDRECHT : HOLLAND / BOSTON : U.S.A.
LONDON : ENGLAND

THE HR DIAGRAM



HENRY NORRIS RUSSELL

INTERNATIONAL ASTRONOMICAL UNION
UNION ASTRONOMIQUE INTERNATIONALE

SYMPOSIUM No. 80

HELD AT THE NATIONAL ACADEMY OF SCIENCES, WASHINGTON D.C.
2-5 NOVEMBER, 1977

THE HR DIAGRAM

The 100th Anniversary of Henry Norris Russell

EDITED BY

A. G. DAVIS PHILIP

Dudley Observatory and Union College

AND

D. S. HAYES

Arizona State University



D. REIDEL PUBLISHING COMPANY

DORDRECHT : HOLLAND / BOSTON : U.S.A. / LONDON : ENGLAND

1978

Library of Congress Cataloging in Publication Data

Main entry under title:

The HR Diagram.

(Symposium – International Astronomical Union ; no. 80)

Includes bibliographies and indexes.

1. HR diagrams – Congresses. 2. Stars – Congresses. 3. Russell, Henry Norris, 1877–1957. I. Russell, Henry Norris, 1877–1957. II. Philip, A. G. Davis. III. Hayes, Donald S. IV. Series: International Astronomical Union. Symposium ; no. 80.

QB815.H18 523.8 78–19125

ISBN 90–277–0905–X

ISBN 90–277–0906–8 pbk.

*Published on behalf of
the International Astronomical Union
by*

D. Reidel Publishing Company, P. O. Box 17, Dordrecht, Holland

*All Rights Reserved
Copyright ©1978 by the International Astronomical Union*

*Sold and distributed in the U.S.A., Canada, and Mexico
by D. Reidel Publishing Company, Inc.
Lincoln Building, 160 Old Derby Street, Hingham,
Mass. 02043, U.S.A.*

No part of the material protected by this copyright notice may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying, recording or by any informational storage and retrieval system, without written permission from the publisher

Printed in The Netherlands

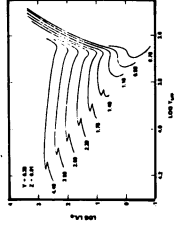
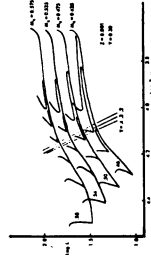
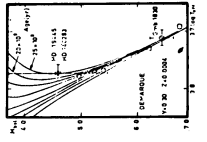
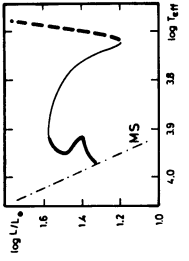
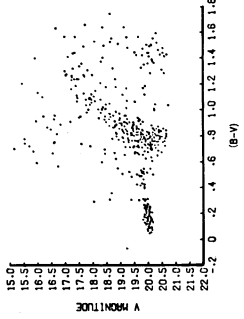
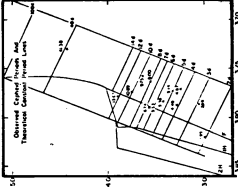
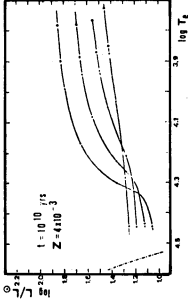
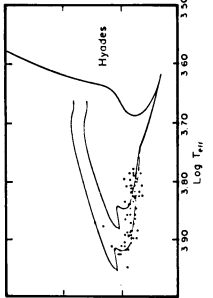
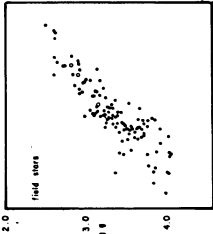
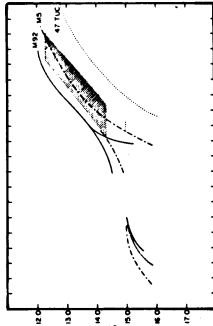
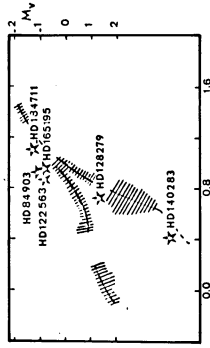
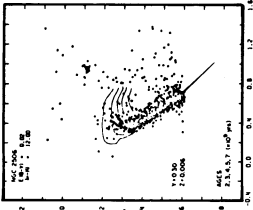
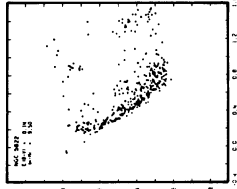
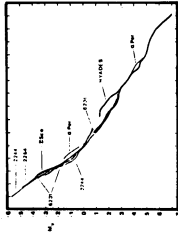
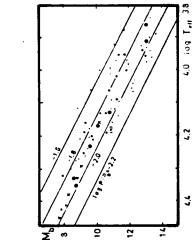
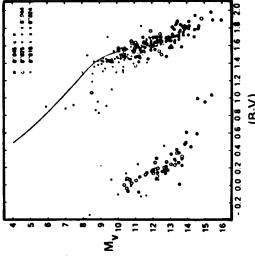
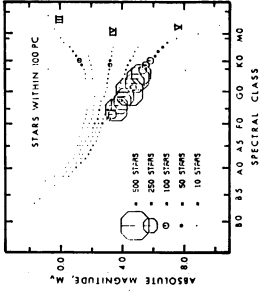
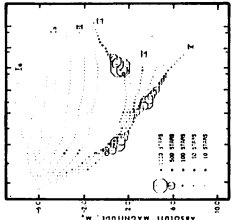
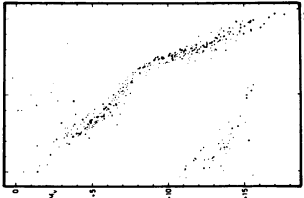
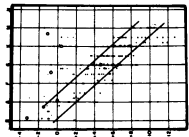


TABLE OF CONTENTS

Preface	xiii
List of Figures	xix
List of Participants	xxi

I. FUNDAMENTALS OF THE HR DIAGRAM

W.W. MORGAN / Some Uses of Spectral Classification in HR Diagrams	3
NOLAN R. WALBORN / Some Progress and Problems in the Upper Left of the HR Diagram	5
PHILIP C. KEENAN / A More Accurate HR Diagram for the Cooler Stars	13
PATRICIA C. BOESHAAR / Spectroscopic Observations of Late-Type Halo M Dwarfs	21
I. APPENZELLER and H. ZEKL / A Computer Method for Spectral Classification	23
M. PARTHASARATHY / Red and Blue Stars in the Direction of the Large Magellanic Cloud	25
TH. SCHMIDT-KALER / Quantitative Two-Dimensional Classifications of Low Dispersion Objective Prism Spectra	29
V.M. BLANCO, A.A. HOAG, and M.F. McCARTHY / Carbon and Late-Type M Stars as Population Indicators	33
ARTHUR R. UPGREN / Main Sequences Defined by Hyades and Field Stars	39
ANDRÉ HECK / Absolute Magnitudes by Statistical Parallaxes	49
S.V.M. CLUBE and J.A. DAWE / RR Lyrae Variable Stars and the Distance Scale	53
ROBERT E. STENCEL / Extensions of the Wilson-Bappu Effect Among Very Luminous Stars	59
WILLEM J. LUYTEN / Statistical HR Diagrams for One Hundred and Fifteen Thousand Proper-Motion Stars	63
D.S. HAYES / The Absolute Calibration of the HR Diagram: Fundamental Effective Temperatures and Bolometric Corrections	65

II. HR DIAGRAMS, THE SOLAR NEIGHBORHOOD

W. GLIESE / Hertzsprung-Russell Diagrams and Color-Luminosity	
---	--

Diagrams for the Stars Nearer than Twenty-Two Parsecs	79
DON C. BARRY / The Position of the Sun in the HR Diagram	89
NANCY HOUK and ROBERT FESEN / HR Diagrams Derived from the Michigan Spectral Catalogue	91

III. HR DIAGRAMS, SUBLUMINOUS STARS

JESSE L. GREENSTEIN / The HR Diagram	101
HARRY L. SHIPMAN / The Distribution of Masses and Radii of White Dwarf Stars	117
VOLKER WEIDEMANN / The HR Diagram of White Dwarfs	121
PAUL R. WESSELIUS / Ultraviolet Colors of Subdwarf O Stars	125
C.C. DAHN and R.S. HARRINGTON / Subluminous Stars in the HR Diagram	129
S. TAPIA / Empirical Evidence for Crystallization Sequences of DA Type White Dwarfs	133

IV. HR DIAGRAMS, CLUSTERS

A. GUTIÉRREZ-MORENO and H. MORENO / Spectrophotometry in Stellar Associations	139
WILLIAM HERBST and ROBERT J. HAVLEN / A Photometric Study of Ara OB1	143
D.L. CRAWFORD / Four-Color and H β Diagrams for Open Clusters - A Survey	145
R.F. GARRISON / The Main Sequence of NGC 6231 and the Calibration of Absolute Magnitudes	147
PHILLIP J. FLOWER / The Hyades Cluster - Too Distant?	151
HELMUT A. ABT and HUGO LEVATO / The Occurrence of Peculiar Stars in Open Clusters	155
CATHERINE A. PILACHOWSKI and WALTER K. BONSAK / The Clump Giants: A Spectroscopic Survey of G and K Giants in Open Clusters	157
RICHARD C. HENRY and JAMES E. HESSER / K-Line Photometry: Coma and NGC 6475	161
ALAN HIRSHFELD, ROBERT D. McCLURE, and BRUCE A. TWAROG / Measurements of Abundances and Ages of Old Disk Clusters	163
ROBERT P. KRAFT / Evidence for Non-Homogeneity in the Metal Abundances of Stars in Globular Clusters	167

M. SPITE and F. SPITE / A Comparison Between the Relative Heavy Metal Abundance of the Extreme Halo Field Stars and Giant Stars of Globular Clusters	169
GEORGE WALLERSTEIN and CATHERINE PILACHOWSKI / Observations of CO and OI in Stars in Globular Clusters	173
R. CANTERNA and R.A. SCHOMMER / The Chemical Abundances of the Halo Clusters of the Galaxy	177
DENNIS BUTLER, ROGER A. BELL, R.J. DICKENS, and ELIZABETH EPPS / A Combined Photometric/Spectroscopic Study of RR Lyrae Stars in the Globular Cluster Omega Centauri	183
JOHN NORRIS / The Role of Mixing and Primordial Abundance Variations in 47 Tucanae and ω Centauri	195
T. LLOYD EVANS / The Anomalous Giant Branch of ω Centauri	205

V. HR DIAGRAMS, HORIZONTAL BRANCH

A.G. DAVIS PHILIP / Horizontal-Branch Stars in the $\text{Log } T_{\text{eff}}$, $\text{Log } G$ Diagram	209
VITTORIO CASTELLANI / The Expected Morphology of Zero Age Horizontal Branches	221
F. FUSI-PECCI and A. RENZINI / Evolution of Globular Cluster Stars with Mass Loss and Core Rotation	225
J.W. PEL and J. LUB / Physical Properties of Cepheids and RR Lyrae Stars	229
ARTHUR N. COX and STEPHEN W. HODSON / Pulsation Modal Behavior of Classical Cepheids in the HR Diagram	237
L.A. BALONA / The Radii of RR Lyrae Stars	241

VI. GALAXIES AND MISCELLANEOUS SUBJECTS

BEATRICE M. TINSLEY / HR Diagrams of Galaxies: Ages and Stages of Evolution	247
DAVID CRAMPTON / Luminosities of LMC OB Stars	259
ROBERTA M. HUMPHREYS / The HR Diagram for Luminous Stars in Nearby Galaxies	263
ROBERT A. SCHOMMER, EDWARD W. OLSZEWSKI, and WILLIAM E. KUNKEL / A Preliminary Color-Magnitude Diagram for the Ursa Minor Dwarf Galaxy	269
SIDNEY VAN DEN BERGH / The Hertzsprung-Russell Diagram of Metal-Poor Disk Stars	273

M. GOLAY / The Use of Praesepe for the Definition of the Lower Part of the Zero-Age Main Sequence	277
DAVID S. EVANS / A New Kind of HR Diagram?	281
B. HAUCK / Detection of Am and Ap Stars by Photometric Means	285
EUGENIO E. MENDOZA V / The HR Diagram of Abnormal A-Type Stars	289
V. STRAIŽYS / From Multicolor Photometric Indices to the HR Diagram	293

VII. THEORETICAL PAPERS AND SUMMARY

HELMUTH KÄHLER / The Vogt-Russell Theorem, and New Results on an Old Problem	303
G. CAYREL DE STROBEL and M.N. PERRIN / Comparison Between Observational and Theoretical ($\log T_{\text{eff}}$, M_{bol}) Diagrams	313
M.N. PERRIN and G. CAYREL DE STROBEL / Is it Possible to Derive the Position of a Star in the HR Diagram from Multicolor Photometry?	319
PETER G. GROSS / On Magnetic Mixing and Rotation in Stellar Evolution	323
ALLEN V. SWEIGART / Survey of Some Recent Stellar-Evolution Calculations	333
R.B. CIARDULLO and P. DEMARQUE / The Evolution of the Integrated Colors of Globular Clusters and Elliptical Galaxies	345
SUSAN A. LAMB / Evolution of Massive Stars Through Late Evolutionary Phases	349
C. CHIOSI / The Structure and Evolution of Massive Stars	357
PETER S. CONTI / Evolution of Massive Stars: When Does an Of Star Become a WR Star?	369
DAVID S.P. DEARBORN and VIRGINIA TRIMBLE / Nucleosynthesis in Massive Population II Stars	375
R.A. BELL and B. GUSTAFSSON / The Colors of G and K Giant Stars	379
R. FOY / Microturbulence as a Third Dimension in the G-K Giant Region of the HR Diagram	383
KEIICHI KODAIRA / Sphericity Effects of Extended Atmospheres of Late-Type Giants in the HR Diagram	387
LOUIS C. GREEN / Summary	391
Continuation of Discussion	405

POSTER SESSION

THOMAS B. AKE / A Revised Classification System in the Red for S Stars	409
H.J. AUGENSEN and W. BUSCOMBE / Southern High-Velocity Stars	413
WILLIAM P. BIDE LMAN / On G.P. Kuiper's Work on the Stars of Large Proper Motion	417
I. FURENLID and W.L. SANDERS / A B-Star High Luminosity Indicator	421
JOHANNES HARDORP / The Main Sequence at G2 V	423
WILLIAM HERBST, RENE RACINE, and JOHN W. WARNER / Optical and Infrared Properties of the Newly Formed Stars in CMa R1	427
KEIICHI ISHIDA and TAKAO MIKAMI / Luminosity Calibration of Late-Type Stars by Statistical Parallax using AGK3 Proper Motions	429
H.E. JØRGENSEN / Fundamental Parameters and the Helium Content of Eclipsing Spectroscopic Binaries	433
JAMES LIEBERT / Extending the White Dwarf Sequence: Plans and Prospects	437
BERNARD J. McNAMARA and W.L. SANDERS / Peculiarities in Some Cluster Color-Magnitude Diagrams	441
LAWRENCE J. RELYEA and A.G. DAVIS PHILIP / The Strömrgren Four-Color System and the $\log T_{\text{eff}}$, $\log G$ Diagram	443
NATHANIEL M. WHITE / Angular Diameters of Cool Stars Measured by the Method of Lunar Occultations	447
ROBERT F. WING and NATHANIEL M. WHITE / Two-Dimensional Spectral Classification of M Stars by Narrow-Band Photometry	451
Index	455