School of Astrophysics "F. Lucchin"

X Cycle, First Course 2008

Tarquinia (Italy), June 8-14, 2008

Scientific Organizing Committee

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C. Chiosi (Univ. of Padua), L. Moscardini (Univ. of Bologna)

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G. Giobbi (INAF-OAR, Rome), P. G. Prada Moroni (Univ. of Pisa)

Organized by:

Istituto Nazionale di Astrofisica
INAF–Osservatorio Astronomico di Padova
INAF–Osservatorio Astronomico di Roma
Società Astronomica Italiana

Sponsored by:

Comune di Tarquinia

Edited by:

Pier Giorgio Prada Moroni and Giuseppe Bono

FOREWORD

The first course of the X cycle of the 2008 School of Astrophysics "F. Lucchin" was held in Tarquinia[1] (Viterbo, Italy) on June 8-14, 2008. According to tradition, the School addressed two different topics: *Advanced Stellar Evolutionary Phases* (Chair: G. Bono) and *Technologies for the Next Generation of Ground-Based Telescopes* (Chair: R. Ragazzoni). The lectures were held in the Council Hall of the Palazzo Comunale (XI century). The official language was, for the first time, English and more than 70 participants coming from ten different countries attended the School.

During the 4.5 days of the School, two dozen lectures were given together with a dozen short oral presentations by the participants. The current proceedings only include the lectures on stellar evolution, and we are grateful to all the scholars for sending us the written edition of their lectures. This is the first time that the lectures of the School are printed and their effort will stand forever as a written memory. At the same time, we are also very grateful to the Scientific Advisory Board, to the editor of *Memorie della Società Astronomica Italiana*[2], Piercarlo Bonifacio for giving us this opportunity, and to the editorial staff for the help in the final revision of the contributions.

The programme of the School followed in detail the suggestions of the SOC, i.e. a limited number of lectures and long coffee, lunch and tea breaks so as to give the chance for profitable discussions between scholars and participants. The School started with the welcome reception and registration on Sunday, June 8, in the reception room of the Museo Nazionale Etrusco[3] (Palazzo Vitelleschi, XV century). It was a warm summer afternoon with a beautiful view on the Tyrrhenian Sea at sunset. Officially, the School started on Monday, with the welcome address of Dr. M. Mazzola, the Major of Tarquinia. The Social Dinner was held in the Restaurant *All'olivo* on Wednesday 11. The atmosphere was very pleasant, not only for the quality of food and drinks, but also for the lively music. During the School, we have had the opportunity to visit the National Etruscan Museum, the necropolis of Monterozzi and, for the Social Excursion on Thursday 12, we planned to visit instead the Parco Naturalistico Archeologico di Vulci[4]. Unfortunately, because of a heavy rain, we decided to visit the Museo Nazionale Etrusco hosted inside the Castello della Badia (XII century).

We would like to thank the technical and administrative staff of both Rome and Padua Observatories, and in particular Giuliana Giobbi and Giorgia Ortolani for solving several difficult problems before and during the School. We are also very grateful to Giuliana for her crucial help in dealing with the proceedings, to Marco Castellani for mastering the web page of the School and to the LOC members for their constant support in the organization of the School.

It is a pleasure to thank the Major, Dr. M. Mazzola, and the Consiglio Comunale of Tarquinia, for giving us the opportunity to use the Council hall. We are particularly indebted to A. Iacopucci and S. Pelucco for their invaluable logistic support before and during the meeting and to Federica and Linda (Malindi Dolce Viaggiare Travel Agency) for their fundamental help in dealing with hotel reservations, local transportation and restaurant selection.

The poster of the meeting, the cover of the proceedings and the logo on the backpack were created by OM Grafica[5]. We would like to express our deep gratitude for their friendly service.

[1] http://www.tarquinia.net/
[2] http://sait.oat.ts.astro.it/
[3] http://www.archeologia.beniculturali.it/pages/atlante/S76.html#Contatti
[4] http://www.vulci.it/
[5] http://www.exormaedizioni.com/

The conference was sponsored by the National Institute for Astrophysics[6] (INAF), the Astronomical Observatory of Rome[7] and the Astronomical Observatory of Padua[8], the Italian Astronomcal Society[9] (SAIT) and the Tarquinia Municipality.

We also wish to express our thanks to Dott.ssa M. Cataldi, Director of the Museo Nazionale Etrusco in Tarquinia, for helping us in solving the bureaucratic problems for using the reception room.

R. Ragazzoni and G. Bono

[6] http://www.inaf.it/
[7] http://web.oa-roma.inaf.it/
[8] http://www.oapd.inaf.it/
[9] http://www.sait.it/index.php

Cover and poster illustration:

The lower portion of the poster shows a painting from the *The Tomb of the Leopards*. This single-chamber tomb is located in the etruscan necropolis of Monterozzi east of Tarquinia, a UNESCO human heritage site since July 2004. The tomb dates back to V sec BC, and was discovered almost two centuries ago. Its name comes from two leopards (panthers), facing each other around a tree, painted on the tympanum of the back wall. The main painting shows a banquet of three couples lying on *klinai*, while the paintings on the side walls show musicians playing either the double flute or the lyre, dancers and boys carrying votive oblations. These paintings and the *Winged Horses* are the most famous symbols of Tarquinia, throughout the world.

The upper portion of the poster shows the Large Binocular Telescope (LBT) and its dome. The LBT is a large optical – near-infrared telescope consisting of two 8.4m mirrors on a common mount located on Mt. Graham (Arizona, USA). The LBT is a collaboration between INAF, The University of Arizona, Arizona State University, Northern Arizona University, the LBT Beteiligungsgesellschaft in Germany, The Ohio State University, Research Corporation in Tucson, and the University of Notre Dame[10].

Two Color-Magnitude diagrams of the globular cluster Omega Centauri are superimposed to the LBT picture. They are based on optical ($F435W$, $F625W$, $F658N$) images collected with the Advanced Camera for Surveys on board the Hubble Space Telescope and on near-infrared (J, K) images collected with MAD at the Very Large Telescope (ESO, Paranal). In particular, they show the region of the white dwarfs (right) and of the horizontal branch stars (left). The colored symbols mark peculiar objects, while the colored lines display theoretical predictions for white dwarf cooling sequences (Calamida et al. 2008).

[10] More details can be found at the following URL `http://medusa.as.arizona.edu/lbto/`

School of Astrophysics ”F. Lucchin”

The School of Astrophysics for PhD students was initiated almost twenty years ago by Professor Francesco Lucchin. The key idea was to organize twice a year a school in different locations to attract a substantial fraction of PhD students during their doctorate. Moreover, in order to avoid very specific lectures, he suggested to cover in each course two different astrophysical topics. The far-sightedness of this idea is demonstrated by the fact that, this year, we are organizing the first course of the X Cycle of the School, which is now called School of Astrophysics ”F. Lucchin”. For those who have been involved in the organization of National and International schools, the most important problem is continuity. The stumbling block was overcome, and different generations of PhD students and scholars have attended the School in a lively atmosphere. The School of Astrophysics ”F. Lucchin”[11] is now a solid reality and our debt of gratitude goes to Francesco.

List of School of Astrophysics ”F. Lucchin”

I Cycle, First Course – Monte Porzio Catone – May 20-25, 1991
Astrofisica Stellare (Chair: V.Castellani)
Nuclei Galattici Attivi (Chair: A. Cavaliere)

I Cycle, Second Course – – Septemeber 16-21, 1991
Acquisizione e riduzione dati – Strumentazione (Chair: M. Capaccioli)
Cosmologia (Chair: F. Lucchin)

I Cycle, Third Course – Tremezzo – May 4-9, 1992
Galassie (Chair: F. Bertola)
Astrofisica Relativistica (Chair: C. Perola)

I Cycle, Fourth Course – – September 7-12, 1992
Astrofisica dei Plasmi (Chair: A. Ferrari)
Fisica del Sistema Solare (Chair: C. Chiuderi)

II Cycle, First Course – S. Miniato – March 13-19, 1993
Fisica Solare (Chair: E. Landi degl’Innocenti)
Astronomia Infrarossa (Chair: A. Bonetti)

II Cycle, Second Course – S. Agata sui due Golfi – September 20-25, 1993
Cosmologia (Chair: F. Lucchin)
Evoluzione Stellare (Chair: C. Chiosi)

II Cycle, Third Course – Marciana Marina – May 16-20, 1994
AGN–Oggetti collassati (Chair: R. Fanti)

[11] More details concerning individual Scool of Astrophysics can be found at the following URL `http://urania.bo.astro.it/snaf.html`

Fisica del Sistema Solare (Chair: P. Paolicchi)

II Cycle, Fourth Course – Palermo – October 17-21, 1994
Astrofisica dei Plasmi (Chair: S. Serio)
Galassie (Chair: M. Capaccioli)

III Cycle, First Course – Monte Porzio Catone – May 15-19, 1995
Strumentazione–Acquisizione dati (Chair: R. Buonanno)
Fisica Solare (Chair: B. Caccin)

III Cycle, Second Course – Asiago – October 9-14, 1995
Cosmologia (Chair: S. Bonometto)
Astronomia Infrarossa (Chair: A. Natta)

III Cycle, Third Course – Teramo – May 5-11, 1996
AGN–Oggetti Collassati (Chair: A. Treves)
Evoluzione Stellare (Chair: A. Renzini)

III Cycle, Fourth Course – Pettenasco – September 22-28, 1996
Fisica del Sistema Solare (Chair: L. Nobili)
Plasmi Astrofisici (Chair: V. Zappalà)

IV Cycle, First Course – Acireale – May 26-30, 1997
Galassie (Chair: G. Bertin)
Fisica Solare e Stellare (Chair: M. Rodono')

IV Cycle, Second Course – Asiago – September 8-13, 1997
Nuovi Telescopi (Chair: C. Barbieri)
Cosmologia (Chair: S. Matarrese)

IV Cycle, Third Course – Monte Porzio Catone – June 15-20, 1998
Fisica del Sistema Solare (Chair: A. Carusi)
Astrofisica Relativistica (Chair: L. Stella)

IV Cycle, Fourth Course – Riccione – October 5-10, 1998
Mezzo Interstellare (Chair: F. Palla)
AGN–Oggetti Collassati (Chair: G. Zamorani)

V Cycle, First Course – Carloforte – June 7-12, 1999
Popolazioni Stellari come Orologi Cosmici (Chair: F. Fusi Pecci)
Dal Lontano Infrarosso al Millimetrico (Chair: M. Felli)

V Cycle, Second Course – Isola d'Elba – September 20-25, 1999
Proprietà Globali delle Galassie (Chair: R. Sancisi)
Strumentazioni Spaziali (Chair: E. Costa)

V Cycle, Third Course – Mondello – May 29 June 2, 2000
Plasmi Astrofisici (Chair: R. Pallavicini)
Novae e Supernovae (Chair: C. Chiosi)

V Cycle, Fourth Course – Asiago – September 10-16, 2000
Formazione di Galassie (Chair: N. Vittorio)
Nuclei Galattici Attivi (Chair: M. Salvati)

VI Cycle, First Course – Sirolo – May 21-25, 2001
Corpi Minori del Sistema Solare (Chair: G. Valsecchi)
Struttura, Evoluzione e Variabilità Stellare (Chair: A. Tornambe')

VI Cycle, Second Course – Trieste – October 15-19, 2001
Chemical evolution of Galaxies (Chair: J. Danziger)
High Resolution Spectroscopy and the Cosmic Evolution (Chair: P. Molaro)

VI Cycle, Third Course – Cetraro – June 3-7, 2002
Turbulence in Space Plasmas (Chair: P. Veltri)
Galaxies and Galaxy Systems (Chair: G. Vettolani)

VI Cycle, Fourth Course – Asiago – September 8-14, 2002
Cosmologia (Chair: G. De Zotti)
Astrofisica Relativistica (Chair: M. Vietri)

VII Cycle, First Course – Marciana Marina – May 11-17, 2003
Le Galassie del Gruppo Locale (Chair: C. Chiosi)
I Telescopi di Nuova Generazione (Chair: G. Tofani)

VII Cycle, Second Course – Costa Rey – September 27 – October 3, 2003
Astrofisica del Mezzo Interstellare (Chair: S. Aiello)
Oggetti Compatti e Pulsar (Chair: A. Treves)

VII Cycle, Third Course – Bertinoro – May 16-21, 2004
Lensing Gravitazionale (Chair: G. Bertin)
Il Caos e le sue Conseguenze Astrofisiche (Chair: A. Milani)

VII Cycle, Fourth Course – Asiago – September 5-11, 2004
Parametri Cosmologici (Chair: S. Matarrese)
Pianeti Extrasolari (Chair: R. Gratton)

VIII Cycle, First Course – S. Agata sui due Golfi – May 8-13, 2005
Cosmologia Osservativa a Grande Campo (Chair: M. Capaccioli)
Scala delle Distanze (Chair: C. Chiosi)

VIII Cycle, Second Course – Volterra – October 10-15, 2005
Il Sistema Solare Esterno e la Missione Cassini (Chair: A. Coradini)
Formazione Stellare (Chair: F. Palla)

VIII Cycle, Third Course – Bertinoro – May 7-12, 2006
Dinamica delle Galassie (Chair: L. Ciotti)
Nuclei Galattici Attivi (Chair: A. Comastri)

VIII Cycle, Fourth Course – Trieste – October 1-6, 2006
Ammassi di Galassie (Chair: S. Borgani)
Plasmi Astrofisici (Chair: M. Velli)

IX Cycle, First Course – Maracalagonis – May 20-26, 2007
Oggetti Compatti e Pulsar (Chair: N. D'Amico)
Scienza con ALMA (Chair: L. Testi)

IX Cycle, Second Course – Isola di San Servolo – September 16-22, 2007
Fundamental Physics Using Gamma-Ray Bursts (Chairs: M. Della Valle, G. Tagliaferri)
The Atmospheres of the Terrestrial Planets (Chair: A. Adriani)

X Cycle, First Course – Tarquinia – June 8-14, 2008
Advanced Stellar Evolutionary Phases (Chair: G. Bono)
Technologies for the Next Generation of Ground-Based Telescopes (Chair: R. Ragazzoni)

X Cycle, Second Course – Asiago – September 21-27, 2008

Gamma Astrophysics (Chairs: A. Celotti, G. Ghisellini)
Galaxy Formation: a Stellar Perspective (Chairs: C. Chiosi)

X Cycle, Third Course – Bertinoro – May 24-29, 2009
Cosmological Backgrounds (Chair: G. De Zotti)
Statistical Methods for Astrophysics (Chair: G. Zamorani)

X Cycle, Fourth Course – Abbazia di Spineto – September 7-11, 2009
First Light After the Dark Ages (Chair: F. Haardt)
Simulations of Complex Phenomena in Astrophysics (Chair: F. Califano)