

IAU Symposium

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Proceedings of the International Astronomical Union

Tracing the Ancestry of Galaxies: On the Land of our Ancestors

Edited by

Tracing the
Ancestry of
Galaxies:
On the Land
of our
Ancestors

13-17 December 2010
Ouagadougou, Burkina Faso

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Françoise Combes
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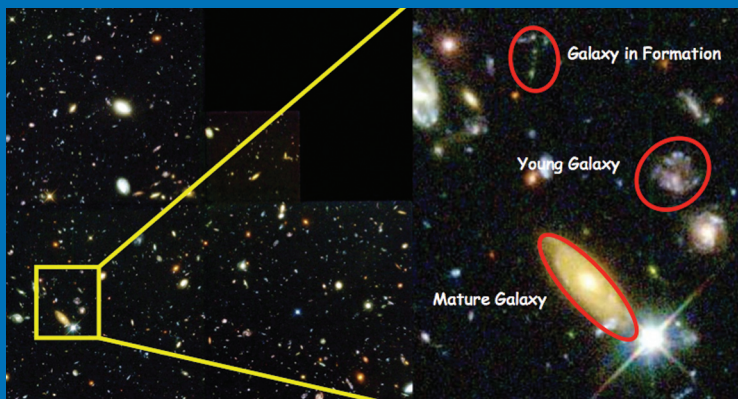
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TRACING THE ANCESTRY OF GALAXIES (on the land of our ancestors)

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This is an enlargement of the Hubble Deep Field (HDF) showing galaxies at different stages of their evolution.

The HDF is based on observations made with the NASA/ESA Hubble Space Telescope, which is operated by the Association of Universities for Research in Astronomy, Inc., under NASA contract NAS 5-26555.

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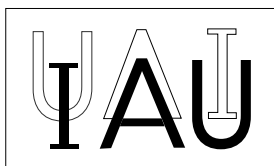
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**TRACING THE ANCESTRY
OF GALAXIES**
(on the land of our ancestors)

**PROCEEDINGS OF THE 277th SYMPOSIUM OF THE
INTERNATIONAL ASTRONOMICAL UNION
HELD IN OUAGADOUGOU, BURKINA FASO
DECEMBER 13-17, 2010**

Edited by

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Table of Contents

Preface	xi
Organizing committees	xii
Conference photograph	xiii
Conference participants	xiv
Address by the Ministre des Enseignements Secondaire, Supérieur et de la Recherche Scientifique (MESSRS)..... <i>Pr. Joseph Paré</i>	xv
Address by the Scientific Organizing Committee	xvii
<i>Pr. Claude Carignan, SOC co-chair</i>	

Session 1. Large Photometric (UV, optical, IR) Surveys

Chair: Ken C. Freeman

The AKARI Far-Infrared Surveyor (FIS): all-sky Diffuse Map	1
<i>S. Komugi, Y. Doi, M. Hattori, Y. Kitamura, T. Otsubo, M. Tanaka, N. Ikeda, D. Kato and T. Nakagawa</i>	
Hidden and Visible Star Formation: New Insights from Herschel	5
<i>V. Buat, E. Giovannoli, S. Heinis and the HerMES team</i>	
Environmental Effects on Galaxy Luminosity Functions in Clusters.....	9
<i>F. Durret, C. Adami and T. F. Lagana</i>	
Shaken, not Stirred: the Ancestry of the Starburst Galaxy NGC 253.....	13
<i>T. J. Davidge</i>	
The Environments of Luminous IR Galaxies	17
<i>A. G. Tekola, P. Visnen and A. Berlind</i>	
AGN and Host Galaxies in the COSMOS Survey.....	21
<i>C. D. Impey, J. R. Trump, J. M. Gabor and the COSMOS team</i>	
Cold Dust and its Heating Sources in M33	26
<i>S. Komugi et al.</i>	
Mid-Infrared Spectral Assessment of Early-Type Galaxies with Star Formation	30
<i>L. L. Leew, J. D. Bregman, J. Davidson, P. Temi and S. S. Im</i>	
Local Group Galaxies in the Infrared.....	34
<i>J. Menzies</i>	
Super Star Cluster Luminosity Functions in Interacting Luminous Infrared Galaxies	37
<i>Z. Randriamanakoto and P. Visnen</i>	

Session 2. Large HI & CO surveys

Chair: Erwin de Blok

HI Imaging Surveys: Gas and Galaxy Evolution in Different Environments – review <i>J. van Gorkom</i>	41
Molecular Gas in Galaxies at all Redshifts – review <i>F. Combes</i>	47
Molecular Gas and Star Formation in Local Early-type Galaxies <i>M. Bureau et al.</i>	55
The Westerbork HALOGAS Survey: Status and Early Results <i>G. Heald, J. Allan, L. Zschaechner, P. Kamphuis, R. Rand, G. Jozsa and G. Gentile</i>	59
Gas and Dust in M 33 <i>J. Braine, P. Gratier, C. Kramer, B. Mookerjee, M. Xilouris and D. Calzetti</i>	63
NRO Legacy Project: M33 all Disk Survey of Giant Molecular Clouds with NRO 45-m and ASTE 10-m Telescopes <i>N. Kuno et al.</i>	67
Warps and Accretion <i>G. I. G. Jozsa</i>	71
What Radio Astronomy Can Tell us about Galaxy Formation <i>B. Partridge</i>	75
Comparisons of CO and HI Dynamics in THINGS Galaxies <i>B. S. Frank, W. J. G. de Blok and the HERACLES team</i>	79

Session 3. Large 3D Kinematical Surveys – low z

Chair: Martin Bureau

Integral-Field Spectroscopic Surveys of Nearby Early-type Galaxies – review . . <i>E. Emsellem</i>	83
3D Spectroscopic Surveys of Late-type Nearby Galaxies in the Optical – review <i>P. Amram</i>	89
The MeerKAT Karoo Array Telescope and its HI Emission Line Surveys <i>W. J. G. de Blok</i>	96
The Study of Barred Spiral Galaxies with Integral-Field Units (IFUs) <i>C. Robert, S. Cantin, E. Brice, L. Laurie-Nepton and L. Drissen</i>	100
SpIOMM and SITELLE: Wide-Field Imaging FTS for the Study of Galaxy Evolution. <i>L. Drissen, A.-P. Bernier, C. Robert and the SpIOMM & SITELLE team</i>	104
African Eyes on the Sky – the Southern African Large Telescope (SALT) <i>P. Väisänen</i>	108
HII Regions of NGC 628 and M101 as Seen with SpIOMM. <i>L. Rousseau-Nepton, C. Robert and L. Drissen</i>	112

HI and H α Mapping of M31 & M33.	116
<i>Z. S. Kam, C. Carignan, L. Chemin, O. Hernandez, M.-M. de Denus-Baillargeon and Y. Djabo</i>	

Session 4. Large 3D Kinematical Surveys – high z

Chair: Françoise Combes

Large High Redshift Spectroscopic Surveys review	121
<i>O. Le Fevre</i>	
3D Spectroscopic Surveys: Exploring Galaxy Evolution Mechanisms – review. . .	128
<i>B. Épinat</i>	
Probing the Mass Assembly and Chemical Evolution of high-z Galaxies with MASSIV	134
<i>T. Contini et al.</i>	
The Evolution of the Baryonic Tully-Fisher Relation over the past 6 Gyr	138
<i>M. Puech, F. Hammer, H. Flores, R. Delgado-Serrano, M. Rodrigues and Y. Yang</i>	
Seeking Completeness for high-z ULIRGs: from SCUBA to Herschel	142
<i>C. M. Casey</i>	
Lyman Break Analogs: Constraints on the Formation of Extreme Starbursts at low and high Redshift	146
<i>T. Gonçalves, R. Overzier, A. Basu-Zych and D. C. Martin</i>	
The Turbulent ISM of Galaxies about 10 Gyrs ago: Star Formation, Gas Accretion, and IMF	150
<i>L. Le Tiran and M. D. Lehnert</i>	
Interactive Visualization of 3D Redshift Surveys with SDvision	154
<i>D. Pomarède and M. Pierre</i>	

Session 5. Stellar Populations in the Local Universe and at high z and Galaxy Evolution

Chair: Stéphane Courteau

Modeling Stellar Populations at high Redshift – review	158
<i>C. Maraston</i>	
Tracing the Origin of Bars and Bulges through the Study of their Stellar and Ionized Gas Properties.	166
<i>I. Perez, P. Sanchez-Blazquez, A. Zurita and E. Florido</i>	
The Metallicity Evolution of Galaxies through the Cosmic Epochs	170
<i>R. Maiolino</i>	
The Chemical Enrichment Histories of SDSS Galaxies	174
<i>Johansson, D. Thomas and C. Maraston</i>	
Gas Flows in Galaxies: the Relative Importance of Mergers and Bars	178
<i>S. L. Ellison, D. R. Patton, P. Nair, L. Simard, J. T. Mendel, A. W. McConnachie and J. M. Scudder</i>	

Reconstruction of Star Formation and AGN Activities in Galaxies Classified with the Balmer Break, 1.6 μm Bump and PAH Features up to $z=2$	182
<i>H. Hanami, T. Ishigaki and the AKARI extragalactic team</i>	
Fixing the Stellar M/L Ratio by Chemospectrophotometric Evolution Models . .	186
<i>M.-M. de Denus-Baillargeon, S. Boissier, C. Carignan, O. Hernandez and P. Amram</i>	
A Method to Resolve the Nuclear Activity in Galaxies, as Applied to NGC 1358	191
<i>P.-O. Lindblad and K. Fathi</i>	
Star Formation in Isolated LIRGs: Clues to Star-forming Processes at higher z .	195
<i>I. Fuentes-Carrera, L. Olguín, P. Ambrocio-Cruz, S. Verley, M. Rosado, L. Verdes-Montenegro, P. Repetto, C. Vásquez and V. Aguilera</i>	
Stellar Population in M31 from Broad-band Photometry	199
<i>A. Tamm, E. Tempel, P. Tenjes and T. Tuvikene</i>	

Session 6. Teaching Aids for Astronomy & Virtual Observatory (VO)

Chair: Pius Okeke

Building on IYA2009: IAU Strategic Plan Astronomy for the Developing World review	203
<i>G. Miley, C. Carignan and K. Govender</i>	
Astronomy Education: Research Paving the Road to Enthusiasm for Studying Science review	211
<i>J.-P. de Greve</i>	
Developing Astronomy in Uganda	217
<i>S. K. Anguma and E. Jurua</i>	
Astrophysics in Burkina Faso	220
<i>C. Carignan, L. Turbide and J. Kouliadiati</i>	
The Virtual Observatory: Data, Standards and Tools review	224
<i>C. Surace and the CeSAM team</i>	
AVOCADO: A Virtual Observatory Census to Address Dwarfs Origins	230
<i>R. Sanchez-Janssen and the AVOCADO collaboration</i>	

Session 7. Confronting Cosmological Simulations and Galaxy Evolution Models with Galaxy Samples

Chair: Joe Silk

The Impact of ISM Turbulence, Clustered Star Formation and Feedback on Galaxy Mass Assembly through Cold Flows and Mergers	234
<i>L. Powell, F. Bournaud, D. Chapon, J. Devriendt, A. Slyz and R. Teyssier</i>	

Investigating the Merger Origin of Late-type Galaxies using Ultra-deep Optical Images	238
<i>P.-A. Duc et al.</i>	
Quantifying the Redistribution of Mass in Galactic Disks due to Bars	242
<i>P. Sanchez-Blazquez, I. Perez and P. Ocvirk</i>	
Gas Inflows, Star Formation and Metallicity Evolution in Galaxy Pairs	246
<i>P. Di Matteo, M. Montuori, M. D. Lehnert, F. Combes and B. Semelin</i>	
Chemical Signature of Gas-rich disc-disc Mergers at high Redshift	250
<i>H. Martel, S. Richard, C. B. Brook, D. Kawata, B. K. Gibson and P. Sanchez-Blazquez</i>	
Could M31 Come from a Major Merger and Eject the LMC Away?	255
<i>S. Fouquet, F. Hammer, Y. B. Yang, J. L. Wang, M. Puech and H. Flores</i>	
Numerical Simulations of KPG 302 (NGC 3893 / 96)	259
<i>M. Rosado, R. Gabbasov and I. Fientes-Carrera</i>	
Three-dimensional Visualization of Cosmological and Galaxy Formation Simulations	263
<i>B. Thooris and D. Pomarède</i>	

Session 8. Mass Assembly

Chair: Olivier Le Fèvre

How do Galaxies get their Baryons? – review	267
<i>C. J. Conselice</i>	
Feedback in Galaxy Formation – review	273
<i>J. Silk</i>	
Where is the Light? Tracing the Evolution of Bulges and Disks since $z \sim 0.8$. .	282
<i>L. A. M. Tasca, L. Tresse and the COSMOS & zCOSMOS collaboration</i>	
The Build-up of Mass in UV-selected sub- L^* Galaxies at $z \sim 2$	287
<i>M. Sawicki</i>	
The Evolution of Luminous Compact Blue Galaxies: Disks or Spheroids?	291
<i>D. J. Pisano, K. Rabidoux, C. A. Garland, R. Guzman, F. J. Castander and J. Pérez-Gallego</i>	
Environmental Effects in Galaxy Clusters: Infalling Groups in Abell 85 and 1367	296
<i>H. Bravo-Alfaro, T. C. Scott, E. Brinks, L. Cortese, P. Granados, F. Navarro-Poupard, Y. D. Mayya and F. Durret</i>	
LSST Observations of RR Lyrae Stars for Mapping the Galactic Halo	300
<i>H. Oluseyi et al.</i>	
Breaking Down the Link between Luminous and Dark Matter in Massive Galaxies	305
<i>S. Foucaud and C. Conselice</i>	
Abell 1763 and its Cluster Feeding Filament: Constraints on the Intra-filament Medium	309
<i>L. O. Edwards and D. Fadda</i>	

Session 9. Unsolved Problems

Chair: Claude Carignan

HerMES: Lyman Break Galaxies Individually Detected at $0.7 < z < 2.0$ in GOODS-N with Herschel/SPIRE	313
<i>D. Burgarella, V. Buat, G. Magdis and the HerMES team</i>	
Scale Length of Disk Galaxies	317
<i>K. Fathi</i>	
Ages of Globular Cluster Systems and the Relation to Galaxy Morphology.	321
<i>A. L. Chies-Santos, S. S. Larsen, H. Kuntschner, P. Anders, E. M. Wehner, J. Strader, J. P. Brodie and J. F. C. Santos Jr</i>	
Re-assessment of the Accretion Disc Clock in Hercules X-1	325
<i>E. Jurua, M. Still, P. J. Meintjes, P. A. Charles and S. K. Anguma</i>	
Highly-luminous Cool Core Clusters of Galaxies: Mechanically-driven or Radiatively-driven AGN?	329
<i>J. Hlavacek-Larrondo and A. Fabian</i>	
The Large-scale Structure in the Chandra Deep Field South.	333
<i>D. Trevese, F. Fiore, E. Piconcelli, M. Castellano, L. Pentericci, P. Ranalli and A. Comastri</i>	
Asymptotic Giant Branch Variables in NGC 6822	337
<i>P. A. Whitelock</i>	

Session 10. Summary & Concluding Remarks

Conference summary	341
<i>K. C. Freeman</i>	
Author index	346

Preface

This Symposium was the opportunity to examine the possible links between nearby, mature galaxies and the distant objects that our deepest extragalactic surveys now routinely uncover. Major open questions pertaining to the evolution of these objects into the galaxies we see today were addressed and confronted to theoretical models of galaxy formation and evolution. In recent years, the multi-wavelength mapping of galaxies has enabled a new vision of their structure and composition that may, or may not, be compatible with theoretical precepts.

We are living the golden era of multi-wavelength observations with COSMOS, GOODS, MUSYC, AEGIS and several other surveys probing deep areas of the sky. In the Local Universe, multi-wavelength observations have also reached the survey era with SDSS, SINGS, SINGG, NGVS among others. Sophisticated instrumentation are allowing the comparison of spatially resolved measurements of the dynamics and chemical composition of galaxies at high redshifts (e.g. SINFONI on 8m) with high-resolution kinematical and abundance maps of local galaxies (e.g. 3DNTT on 4m), possibly yielding new insights into the mass assembly and the integrated star formation history of galaxies.

There is emerging evidence that the properties of $z \geq 2$ galaxies are quite drastically different from those of the galaxies in the local universe. Disks appear to be more turbulent and gas-rich, early-types appear to be much smaller for a given mass than their local counterparts and morphologies do not fit in the Hubble sequence of present-day galaxies. Moreover, $z \sim 1$ seems to be the epoch of transition where galaxies start to resemble more the present-day population and where star formation starts to decrease.

One legitimate question to ask is: can we really apply the knowledge gained from low- z studies to the high- z galaxy populations, in view of the strong apparent differences in observed properties? Or do we still have to rely heavily on models/simulations, often based on simplified and likely inadequate recipes for the complex and poorly constrained physical processes involved to interpret high- z observations? With the next generation of facilities coming on line worldwide or in final design stages (e.g. Atacama Large Millimeter Array, Extremely Large Telescopes, James Webb Space Telescope, Large Synoptic Survey Telescope, Square Kilometer Array, etc.) that will allow us to probe galaxies at redshifts $z=1$ or beyond with similar precision as in the local Universe, the time was right at the end of 2010 to assess the current status of the field.

This Symposium wanted to bring together theorists and observers in an attempt to reach a common understanding of the puzzles that our research has recently unfolded, largely through the study of galaxy dynamics and their stellar populations at low and high redshifts. With MeerKAT (Karoo Array Telescope) and SALT (South African Large Telescope) in operation in South Africa and Astrophysics being developed in Burkina Faso and in many other African countries, it seemed timely to hold such a meeting in Africa, especially following the IYA and the resolution of the 2009 IAU General Assembly asking to support the development of Astronomy in emerging countries.

*Claude Carignan and Ken C. Freeman, co-chairs SOC
Ouagadougou, Burkina Faso, December 17, 2011*

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 Antti Tamm, Tartu Observatory, Estonia
 Lidia Tasca, Laboratoire d'Astrophysique de Marseille, France
 Abiy Tekola, University of Cape Town, South Africa
 Bruno Thooris, CEA/IRFU Saclay, France
 Laurence Tresse, Laboratoire d'Astrophysique de Marseille, France
 Dario Trevese, Sapienza Università di Roma, Italy
 Brent Tully, University of Hawaii, USA
 Luc Turbide, Université de Montréal, Canada
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Address by the Ministre des Enseignements Secondaire, Supérieur et de la Recherche Scientifique du Burkina Faso

Dear participants,

En tant qu'ancien président de l'Université de Ouagadougou et qu'ancien diplômé de l'Université de Montréal, je suis très heureux d'accueillir des astrophysiciens de tous les continents au premier Symposium de l'Union Astronomique Internationale en Afrique subsaharienne, hors Afrique du sud, organisé conjointement par l'Université de Ouagadougou et l'Université de Montréal.

I would like to welcome Astrophysicists from all around the world for this first Symposium of the International Astronomical Union in subsaharian Africa, outside South Africa.

Lorsque j'ai rencontré le Prof. Carignan lors d'une visite privée à l'été 2006 à Montréal et que nous avons discuté de la possibilité de mettre sur pied un département d'astrophysique à l'Université de Ouagadougou, j'étais loin de me douter qu'à peine trois (3) ans plus tard, une centaine parmi les meilleurs astrophysiciens au monde se réuniraient à Ouagadougou pour discuter de l'origine des galaxies.

I think that in view of the unfortunately small ressources of Burkina Faso, this is an accomplishment we can be proud of.

Je voudrais remercier tous ceux (je vais sûrement en oublier) qui ont contribué à démarrer l'astrophysique au Burkina Faso et nous ont amené jusqu'au Symposium dont nous inaugurons les travaux ce matin.

- Tout d'abord, la présidente du Comité Local d'Organisation (LOC), Monique Mujawamariya, qui a été la première, lors d'une de ses visites au Burkina, à suggérer la mise sur pied d'un programme d'astrophysique.

- Ensuite, le président de l'Université de Ouagadougou, à qui j'ai demandé de se rendre à deux (2) reprises à Montréal afin d'élaborer le programme d'astrophysique avec le Prof. Carignan et une fois à Marseille afin de tisser les premiers liens permettant le déménagement du télescope Marly de l'Université de Provence du Chili au Burkina Faso.

- Egalement, l'astronome québécois Luc Turbide, présent à ce Symposium, pour le mise en marche et le maintien à distance du télescope d'enseignement ODAUO.

- Je m'en voudrais de ne pas mentionner l'équipe qui s'est rendu au Chili démonter le télescope, le mettre en caisses et qui s'apprêtent à le remonter sur le mont Djaogari dans le nord-est du pays : Daniel Lacroix et Claude Figuière de l'Observatoire de Haute Provence, Claude Carignan et Guillaume Provencher de l'Université de Montréal et Pierre Sanon et Adama Oudraogo de l'Université de Ouagadougou.

Often, we are unfortunately losing our best students who, by lack of the necessary research tools, decide to stay overseas to continue their research. By giving the opportunity to our graduate students to do advanced research on an instrument in Burkina Faso, we should be able to keep them here and maybe attract them back in the country.

Une question légitime à se poser est: pourquoi faire de l'astrophysique au Burkina Faso ? En fait, la majorité des réponses que l'on peut donner s'applique autant à vos pays qu'au Burkina Faso. L'astrophysique doit être vue comme un outil pour intéresser nos jeunes

à la science et à la technologie. C'est pourquoi, au niveau de la maîtrise, nous sommes à mettre sur pied une filière photonique–astrophysique–instruments de mesure. A moyen terme, nous comptons avoir un noyau de quatre (4) astrophysiciens à l'Université de Ouagadougou. Deux, Zacharie Kam Sié et Yacouba Djabo, présents à ce Symposium, sont à compléter un PhD en astrophysique à l'Université de Montréal. En août dernier, le Prof. Carignan et le président Kouliadiati se sont rendus en Afrique du sud afin de mettre sur pied un partenariat permettant d'en former deux (2) autres. En plus de l'aspect formation, l'Afrique du sud s'avère pour nous le partenaire incontournable pour développer la composante recherche puisqu'il possède le plus grand télescope optique dans l'hémisphère sud, le SALT et possiblement dans un proche avenir le plus grand télescope radio, le SKA.

It is clear that with the small resources available, a country such as Burkina Faso cannot catch up in the classical industrial areas. If we cannot catch up, it is clear that a better approach is to try to position ourselves with the front-runners by developing new technologies.

En terminant, je voudrais remercier l'Union Astronomique Internationale de nous avoir accordé sa confiance pour organiser ce Symposium et les formateurs qui vont pendant deux (2) jours former une cinquantaine de professeurs de Lycée de toutes les régions du Burkina. Je voudrais remercier les conférenciers qui donneront des conférences publiques au CCF et de nombreux participants du Symposium qui comptent se rendre donner des conférences dans nos Lycées. Je suis particulièrement content que les premiers travaux visant à mettre sur pied la Société Africaine d'Astrophysique se tiendront également à Ouagadougou cette semaine.

More importantly, I hope that the work you will be doing this week will shed new light on the Origins of Galaxies.

Have a good meeting and welcome.

Pr. Joseph Paré, minister

Hôtel Indépendance, Ouagadougou, December 13, 2010

Address by the Scientific Organizing Committee

Dear colleagues,

Au nom de l'Union Astronomique Internationale, de l'Université de Montréal et de l'Université de Ouagadougou, soyez tous le bienvenu à l'ouverture du Symposium No. 277: Tracing the Ancestry of Galaxies (on the land of our ancestors). Il s'agit du premier Symposium de l'Union Astronomique Internationale à se tenir en Afrique subsaharienne (hors Afrique du Sud).

On behalf of the International Astronomical Union, of the Université de Montréal and of the Université de Ouagadougou, I would like to welcome you all at the opening of IAU Symposium No. 277: Tracing the Ancestry of Galaxies (on the land of our ancestors). This is the first IAU Symposium in subsaharan Africa (outside South Africa).

Comme Ken va vous le dire un peu plus tard, nous pensons que le temps est bien choisi pour avoir un tel Symposium après avoir passé plusieurs années à répertorier de grands échantillons de galaxies proches et de galaxies distantes et avec le développement au cours des dernières années de simulations numériques de plus en plus sophistiquées. En plus de la justification scientifique de tenir un tel Symposium, l'idée de le tenir à Ouagadougou veut aussi marquer le début de l'Astrophysique au Burkina Faso il y a un peu plus de 3 ans et la reconstruction dans le nord-est du pays du télescope Marly, généreusement mis à la disposition de l'Université de Ouagadougou par l'Université de Provence. Ceci va exactement dans le sens du Plan Stratégique adopté à la dernière assemblée générale de l'UAI à Rio de Janeiro en août 2009 où il a été décidé qu'une des priorités de l'Union dans les années à venir sera d'aider au développement de l'Astrophysique dans les pays émergents. Alors merci à vous tous de faire de cette résolution, non seulement un voeu pieux mais une réalité.

We think it is very timely to hold such a meeting on the origin of galaxies after many years of large surveys of nearby and distant galaxies and many years also of more and more accurate numerical simulations. Beside the scientific outcome expected for this meeting, the idea of holding this symposium in Ouagadougou wants to celebrate the beginning of Astrophysics in Burkina Faso more than 3 years ago and the rebuilding in the northeastern part of the country of the Marly telescope kindly allowed to be transferred from Chile to Burkina Faso by the Université de Provence. This is well aligned with the IAU Strategic plan adopted at the IUA general assembly last year in Rio de Janeiro where it was decided that one of the priority of the Union in the next decade will be to help the development of Astrophysics in emergent countries. So thank's to all of you from all around the world to help make of that strategic plan not only some kind of wishfull thinking but a reality.

Cette semaine sera plus qu'un simple Symposium d'Astrophysique mais vraiment un festival d'astrophysique à Ouagadougou puisque plusieurs activités reliées à l'Astronomie vont avoir lieu en parallèle à notre conférence:

This week is more than just an IAU Symposium but a real Astronomy happening in Ouagadougou since many astronomically related activities will run in parallel with our meeting:

- Premièrement, commençant demain matin, nous aurons un atelier du programme Astronomie pour le développement qui se tiendra sur le campus de l'Université de Ouagadougou. L'intention est de donner une formation de base en astronomie à cinquante professeurs de Lycée (1 par province et 5 de Ouaga). Par la suite, nous espérons que ces professeurs seront en mesure de diffuser ces connaissances dans leur région. Grâce à la collaboration de dernière minute de plusieurs participants au Symposium, nous serons aussi en mesure de leur remettre chacun un Galliléoscope qui leur permettra de montrer les merveilles du ciel à leurs élèves.

- **First, starting tomorrow, and for two days, we will hold an IAU / Teaching Astronomy for Development workshop on the campus of the Université de Ouagadougou where we want to give tools to 50 secondary school teachers (1 coming from each of the Burina Faso provinces and 5 from Ouagadougou). Hopefully, they will be able to spread this knowledge in their region. Thank's to the contribution of many Symposium participants, each of them will be able to get back to their school with a Galileoscope and show the wonders of the sky to their students.**

- Pendant toute la semaine, une exposition sur l'Astronomie se tiendra au Centre Culturel Français. Cette exposition se déplacera ensuite vers Bobo. 3 conférences grand public seront également données au CCF par 3 Astrophysiciens du Symposium sur les étoiles, les galaxies et la matière sombre. Un atelier pour de enfants d'age pré-scolaire est aussi organisé au CCF jeudi prochain.

- **During the whole week, an exhibition on Astronomy will be held at the Centre Culturel Français. This exhibition will than move to the CCF in Bobo. Popular talks will also be given by Symposium participants at the CCF on stars, galaxies and dark matter. A small wokshop for pre-school children has also been organized at the CCF next thursday.**

- Mercredi et jeudi, d'autres astronomes Africains d'une douzaine de pays se joindront aux participants du Symposium afin de jeter les bases de ce qui deviendra la Société Africaine d'Astrophysique, qui voudra faire un réseautage de toutes les ressources en Astrophysique sur le continent Africain.

- **On Wednesday and Thursday, other African astronomers from 12 different countries will join the Symposium participants for a workshop that should define the basis of what will become the African Astronomical Society that should help to network all the Astronomy ressources on the continent.**

- Finalement, après un appel à tous fait aux participants du Symposium, douze d'entre eux ont accepté de donner des présentations dans des écoles de Ouaga. 4 iront même rencontrer des enfants dans une garderie de Dassasgo. Il ne servirait à rien de monter un programme d'études gradués à l'Université si on n'essaie pas d'exposer les enfants à l'Astrophysique le plus tôt possible.

- **Finally after a call to the participants, twelve of you have accepted to go and give talks in Ouaga's schools. Four of you will even by going to a kindergarden in Dassasgo. There is no point to start up a graduate program at the University if we do not try to expose them to astronomy as early as possible.**

Je veux donc vous remercier infiniment d'être venus, je vous souhaite une rencontre

scientifique très fructueuse et profiter bien de Ouagadougou pendant son meilleur mois de l'année.

So thank's again for coming, have a fruitful scientific meeting and enjoy Ouagadougou during its best month of the year.

Claude Carignan, co-chair SOC

Hôtel Indépendance, Ouagadougou, December 13, 2010