Report on the 27th International School for Young Astronomers (ISYA)

Morocco, Al Akhawayn University in Ifrane (AUI), July 02-23, 2004

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Michèle Gerbaldi, Chairperson for the ISYA

Ed Guinan, Vice-Chairperson for the ISYA

I - Introduction

The 27th International School for Young Astronomers took place at Al Akhawayn University in Ifrane (AUI), Morocco, under the auspice of Mr. Rachid Benmokhtar Benabdellah, President of Al Akhawayn University.
This new ISYA was organized after that a fist "Teaching for Astronomy Development" (TAD) program has been running since 1999 at the University Hassan II in Casablanca, Morocco. During the opening ceremony, a second TAD agreement has been signed by the International Astronomical Union (IAU) represented by its general secretary Prof. Oddbjorn Engvold and AUI President Mr. Rachid Benmokhtar Benabdellah. Prof. James C. White (TAD chairperson) also attended the ceremony. This new agreement has the objective to support the continued, long-term development of astronomy and astrophysics in Morocco.

AUI is the first Moroccan University which uses the American-style education. It opened in 1995 and has a unique position and role in the Moroccan Educational system. AUI prepares its students for the Bachelor's and Master's degrees. Courses are offered as part of typical curricula in US Universities, but content is tailored for the Moroccan context. The language of instruction for all classes is English.

AUI also develops strong ties with neighboring Universities. Faculty members of the Physics dept. of the Fez University (Faculté des Science, Dhar El Mehraz) showed particular interest to this event and attended the opening day of the ISYA. Two students from the same department were admitted to the ISYA program.

The Organizing Committee consists of a Programme Committee and a Local Organizing Committee

Programme Committee

- Dr. Michèle Gerbaldi (Institut d'Astrophysique, Paris, France)
- Dr. Hassane Darhmaoui (Al Akhawayn University)
- Dr. Khalil Chamcham (Casablanca University, Oxford University, UK)

Local Organizing Committee

- Dr. Amine Bensaid (Al Akhawayn University, School of Science & Engineering) chair
- Dr. Khalil Chamcham (Oxford University)
- Dr. Hassane Darhmaoui (Al Akhawayn University)
- Dr. Ahmed Legrouri (Al Akhawayn University)
- Dr. Khalid Loudiyi (Al Akhawayn University)
- Dr. Tajje-Eddine Rachidi (Al Akhawayn University)
- Dr. Zouheir Sekkat (Al Akhawayn University)
- Dr. Izeddine Zorkani (Faculté des sciences Dhar Mehraz, Fez)
- Members of the astronomy club (Al Akhawayn University)

The *faculty members* were:

- Dr. Bruce Partridge (Haverford College, US)
- Dr. Bruno Guiderdoni (Institut d'Astrophysique de Paris, IAP, France)
- Dr. Jean-Pierre de Grève (Brussels University, Belgium)
- Dr. Joseph Silk (Oxford University, UK)
- Dr. Martin Hendry (University of Glasgow, UK)
- Dr. Pedro G. Ferreira(Oxford University, UK)
- Dr. Mariano Mèndez (SRON - National Institute for Space Research, The Netherland
- Dr. Edward Guinan (Villanova University, USA)
- Dr. Michèle Gerbaldi (Institut d'Astrophysique de Paris, IAP, Université de Paris-Sud Orsay, France)
- Dr. Kavilan Moodley (University of KwaZulu-Natal, South Africa)
- Dr. Ignasi Ribas (Barcelona university, Spain)
- Dr. Abouazza Elmhamdi (SISSA / ISAS, Trieste - Italy/Morocco)
- Dr. Mohammed Badaoui (APESA- Agronomic and Veterinary Institute Hassan II, Rabat - Morocco)
- Dr. Khalil Chamcham(Casablanca University, Oxford University, UK)

Dr. Abouazza Elmhamdi and Dr. Khalil Chamcham were unable to attend the ISYA due to some personal circumstances that had occurred just before the start of the event.

Lecturers and participants were staying on the campus of Al Akhawayn University, located nearby the city of Ifrane, in the Middle Atlas Mountains. The facilities at Al Akhawayn University are of high standard.

The stays duration of ISYA faculty members ranged from 3 days to the whole school duration. Short stays didn't permit real interaction with all participants. Fortunately, the scope of some lectures, for instance cosmology, has been covered by different lecturers and even in the case of short stays, lecturers brought different views and contributed, nevertheless, to fix some notions.

Dr. Ignasi Ribas with the very kind and efficient collaboration of the AUI Information

Technology Services department implemented the packages to reduce and analyze data in astronomy: IRAF, XSPEC, ... under Lynux. 20 PC were available during the all ISYA for such purpose, I. Ribas came before the beginning of the ISYA and prepared the practical activities to be run during the ISYA.

II - Participants

The number of participants was 29: 18 foreigners and 11 Moroccan.

This ISYA was advertised as usual in the Bulletin of the IAU, as well as on the Web Page of the university. Moreover specific information was sent to several institutions being in the geographical area considered for this ISYA.

69 applications, from 26 countries other than Morocco were received. Only 7 applications were not acceptable coming from too far away region such as South America, India or Philippines. 24 foreign students were invited to participate, but 6 of them canceled their participation, at the last moment. One participant came from Malaysia, his participation being required officially by the Malaysian Space Agency.

The foreign participants came from:

Algeria (3, female 1, male 2), Bulgaria (1, male), Iran (3, female 1, male 2), Jordan (1, male), Lebanon (2, male), Macedonia (1, female), Malaysia (1, male), Nigeria (1, female), Palestine (1, male), South Africa (1, female), Sudan (1, male), Turkey (2, male).

There were 11 participants from Morocco (male 7, female 4).
The number of applicants from Moroccan Universities other than AUI was very limited. The LOC considers the language barrier as being the cause. French is the language of instruction in these Universities and most of their students do not master English.
The list of the Participants is given Annexe I.

One week after the beginning of the ISYA on Friday 9th, two applicants from Lybia - not selected to participate - came on their own, claiming that it was very important for them to participate to this ISYA, because Lybia will buy a 2m. telescope, a site survey being currently going on in Lybia. Exchange of e-mails with these applicants has been always difficult: they never have responded to any of our questions concerning their motivation to participate to an ISYA. They stayed at their own expenses 4 days, participated to the lectures and left. Exchange of views, through an informal round table, took place upon their arrival on the best way to become involved into the running of a 2m. telescope.

The background of these 18 foreign participants, ranged from finishing their BSci. degree or having started their PhD about one year ago: 3 had started a PhD, 9 had obtained a MSci, 5 had finished a BSci and one has not yet obtained it. Among the 11

Moroccan participants, 2 came from the Science University Caddi Ayyad, Marrakech, having obtained their MSci, one over two students coming from Fez university had started a PhD (not in astrophysics) and the 7 students from AUI had finished (or not yet) a BSci. Only the students from Marrakech university had a background in astrophysics.
Moroccan graduate studies in astronomy and related subjects are in French and the ability in English of the Moroccan students is such that there is a language barrier which didn't permit many of the students to attend.

III - Academic Activities

English was the language of the ISYA.
The program was arranged as following :

Friday, July 2 (Building 1, board room)
10:00 - 11:00 Registration
11:00 - 11:45 Opening Ceremony of the ISYA
11:45 - 13:00 Campus Tour & Orientation
13:00 - 14:30 Lunch
15:30 - 16:45 Plenary Lecture: "Astrophysics: ... physics at work"
by Professor Michèle Gerbaldi, ISYA chairperson, Institut d'Astrophysique de Paris, France
16:45 - 17: 00 Coffee Break
17:00 - 17:45 Agreement signing ceremony: International Astronomical Union & Al Akhawayn University in Ifrane
17:45 - 18:30 ISYA practical information, technical presentation on computers, etc.

From July 3rd to July 22nd
09:00 - 10:30 Lectures
10:30 - 11:00 Break
11:00 - 12:30 Lectures
12:30 - 15:00 Lunch
15:00 - 16:30 Lectures
16:30 - 17:00 Break
17:00 - 19:00 Lectures / Lab computers

In this programme was also included students talks about their own research.

III - 1 - Lectures

The topics covered by the lectures were:

• Dr. Bruce Partridge
Radio Astronomy and Cosmology
4 lectures (6 hours)

• Dr. Bruno Guiderdoni
Galaxy Formation
3 lectures (4.5 hours)

• Dr. Edward Guinan
Magnetic Activity of the Sun and Solar type Stars
Variable and Eclipsing Stars as Astrophysical Laboratories
4 lectures (6 hours)

• Dr. Ignasi Ribas
Astronomical techniques
4 lectures (6 hours) and computer exercises (10 hours)

• Dr. Jean-Pierre De Grève
Evolution of close binary stars
4 lectures (6 hours) and computer exercises (5 hours)

• Dr. Joseph Silk
Galaxy Formation
3 lectures (4.5 hours)

• Dr. Kavilan Moodley
Cosmological Models
4 lectures (6 hours) and computer exercises (2.5 hours)

• Dr. Mariano Mèndez
High-Energy Astrophysics
4 lectures (6 hours) and computer exercises (5 hours)

• Dr. Martin Hendry
Statistical Astronomy
4 lectures (6 hours) and computer exercises (2.5 hours)

• Dr. Michèle Gerbaldi
Stellar Atmosphere and Data Analysis
3 lectures (4.5 hours)

• Dr. Mohammed Badaoui
Infrared high resolution molecular spectroscopy
2 lectures (3 hours)

• Dr. Pedro G. Ferreira
Cosmology with the Cosmic Microwave Background
4 lectures (6 hours)

In Annexe III are the summaries of the lectures.
Dr. Michèle Gerbaldi, gave two public lectures one to the AUI community and the other in Fes at the Faculté des Science, Dhar El Mehraz.

III - 2 - Practical Activities

More than 25 hours were spent in data reduction and analysis using the astronomical specialized software packages (IRAF) and (XSPEC) among others.

III - 3 - Observations with a small telescope

The telescope (diameter 20cm) granted, in 2002, to Al Jabr School in Casablanca in the frame work of the TAD programme has been kindly on loan to AUI for its use during the ISYA by Al Jabr School. Under the supervision of Ignasi Ribas several observing sessions where organized to which other students from the Al Akhawayn participated. A small led photometer brought by Ed Guinan and a CCD camera brought by Ignasi Ribas were also used. A delta Scuti star was observed and its light curve derived after a simple reduction of the observations.

Occasionally AUI members and students participated also to these observations.
The participants having a skill using small telescope (from Bulgaria and Turkey) played an important rôle as tutor for the AUI students and other participants in order to learn them how to set up such a telescope.

III - 4 - Participant Talks

Sessions were organized for talks by the participants about their work.
17 talks were given, all of them followed by discussions; these 5 sessions added up to 10 hours. The list of these talks is given in Annexe II.
J.P. De Greve analyzed and discussed these oral presentations and gave important clues on how to write a scientific paper. Ed Guinan emphasized on how to write a CV.

IV - Publication of a CdRom

A CdRom containing all the lectures which were digitized has been produced. Each participant received such one CdRom. Concerning the lectures not digitized, photocopies were done.

V - Non-Academic Activities

Non academic activities were organized during the ISYA.
Excursions to Fes, Meknes, Volubulis and to the Middle Atlas Mountains took place on Sunday 4th, 11th and 18th. On Wednesday 21st a closing party was organized attended by the university President.

VI - Budget and Local Organization

The ISYA was located in the building of the School of Science and Engineering.
During the ISYA efficient help was given by the personal of this Department in many practical domains during the ISYA.

This ISYA could be organized thanks to the financial support of ICTP (The Abdu Salam International Center for Theoretical Physics, Italy) and CNRST (Center National pour la Recherche Scientifique et Technique, Morocco).
The Al Akhawayn university has offered the logistic and the necessary support for the venue of this event, as well as the lodging for all the lecturers and participants which facilities were excellent.
Most of the transportation expenses were paid by the IAU budget allocated to this ISYA.
The Abdu Salam International Center for Theoretical Physics sponsorship for travel expenses was appreciated.
Deepest thanks are given to the CNRST and ICTP by the organizers for their support to this ISYA.

The details of the expenses are given in a separate document.

VII - Conclusion

This ISYA took place after the run of a TAD programme which has been effectively and successfully directed by Dr. K. Chamcham at Casablanca university during 5 years.
One of the feedback of this programme would have been the participation, as a lecturer, of a former student of this TAD programme, presently post-doctorate at the SISSA (Trieste - Italy).
Several ISYA participants have discussed their actual thesis orientation with the lecturers in order to complement their formation.
This 27th ISYA was organized in an university having up to now no astronomy programme but starting a new TAD programme, the agreement being signed at the opening of the ISYA. Collaborative programme with the university of Fez is intended.
ISYA 27th also opened its doors to interested AUI students and faculty members who attended some of its activities.
ISYA incited a real interest in astronomy education at AUI. The university will start offering an introductory course in astronomy in the near future. A telescope will be installed at AUI for the use of high school students (through interned) and also university students all over Morocco. The telescope will be linked to a network of telescopes all around the world.

ANNEXE I

List of the ISYA Participants

• Algeria
Amel Zaatri, Algiers
Khalil Daiffallah, Algiers
Macinissa Hadjara, Algiers

• Bulgaria
Galin Borisov, Sofia

• Iran
Azar Nasiri Zarandi, Zanjan
Hossain Safari, Zanjan
Reza Saffari Khomirani, Zanjan

• Jordan
Ali Al-Ta'ani, Mafraq

• Lebanon
Marwan Gebran, Beirut/Toulouse
Abdul Hussein Mroue, Beirut

• Macedonia
Olgica Kuzmanovska, Belgrade

• Malaysia
Mhd Fairos Asillam, Kuala Lumpur

• Morocco
Ali Seddik Didi, Fez
Hassan Boughrous, AUI
Houssaine Taud, AUI
Khadija El Bouchefry, Marakech
Mimoun Hamma, Fez
Mohammed Ouazza, AUI
Nadia Mussaoui, AUI
Nawal Hammane, AUI
Rachid Lghool, AUI
Saida Charafi, Marakech
Zineb Chraibi, AUI

• Nigeria
Anwuli Aba Baiden, Nsukka

• Palestine
Suleiman Baraka, Gaza/Paris

• South Africa
Aletha de Witt, Cape Town
Siddig Abdalla Talha, Sudan/SAAO

• Turkey
Serkan Saygan, Izmir
Timur Sahin, Antalya

ANNEXE II

List of the talks given by the Participants

• Khalil Daiffallah
Magneto-atmospheric waves

• Galin Borisov
Jet structures in the Comet C/NEAT (200LQW4)
Mass loss rate of dust in Comet C/Linear (1999 S4) after its desintegration

• Azar Nasiri Zarandi and Hossain Safari
An exact property of small oscillations of rotating stars

• Reza Saffari Khomirani
Artificial neural network for classification

• Abdul Hussein Mroue
Comets : Oort Cloud
From stars to comets around the Sun: tools and application

• Olgica Kuzmanovska
Influence of stellar rotation on some of the characteristics of the stars

• Mhd Fairos Asillam
Developing robotic telescope in Malaysia

• Suleiman Baraka
Interaction between the solar wind and the Earth magnetosphere

• Siddig Abdalla Talha Sudan/SAAO
Inversion techniques in asteroseismology

• Serkan Saygan
X-1658-298 as an X-ray binary and evolution of X-ray binaries

• Timur Sahin
CCD photometry of Rosat X-ray source RXJ16437+4302

• Ali Seddik Didi
Mono semiconducteur and their applications for CCD cameras

• Khadija El Bouchefry
Quality of astronomical sites

• Nadia Moussaoui
Telescopes

• Saida Charafi
Uniformity and energy resolution of ATLAS and electrognetic calorimeter

ANNEXE III

Summary of the lectures

Dr. Bruce Partridge

Radio Astronomy and Cosmology

I plan to start with fairly basic physics, to provide some worked examples in lecture, and to ask the students to do some small problems in the evenings between lectures. My current plans for my lectures, which would come late in the school, are as follows:-
1. The physics of radio astronomy (1), starting with antenna theory and diffraction through a circular aperture, then continuing on to interference and the combining of signals from two or more apertures. This would provide a brief review of the wave theory of light, including diffraction and interference for the students.
2. The physics of radio astronomy (2):, the size of astronomical signals, stochastic noise, radio receivers and the technique of beam switching and phase sensitive detection.
3. Radio sources and the unified model for active galactic nuclei: thermal emission, bremsstrahlung and synchrotron emission, orientation effects, etc
4. Basic techniques for the detection of the cosmic microwave background (CMB) with emphasis on absolute measurements of intensity and calibration.
5. (If desired) a "cartoon version" of the derivation of the CMB power spectrum. This would be a very low level approach for the less sophisticated students running parallel to Pedro Ferreira's more mathematical coverage.

Dr. Bruno Guiderdoni

Galaxy Formation

I will give a series of lectures on Galaxy Formation. The talks will review recent observational data on high redshift galaxies, the basic concepts involved in hierarchical galaxy formation, the techniques of numerical simulations and the state-of-the-art models.
Lecture 1:
A brief introduction to the Friedman-Lemaitre model
Lecture 2:
Galaxy formation in the Friedman-Lemaitre model
Lecture 3:
Observational properties of high-redshift galaxies

Dr. Jean-Pierre De Greve

Evolution of close binary stars

The foundation: Evolution of single stars.
* Basic equations of stellar structure and recipes to solve them.
* Ingredients for a good solution (equation of state, nuclear reactions, convection, absorption coefficients, ...)
* Complicating ingredients: Overshooting, stellar wind, .. . * Stellar evolution (Phases, differentiations, internal changes, ...)
The ground floor: Binaries and their evolutionary parameters.
* The problem: Additional parameters (P, q, e, Roche lobe approximation)
* Accretion and mixing.
The first floor: Evolution of close binaries.
* Close binary evolution: Phases (results of calculations)
* Different types of evolution, internal changes, ...
* At last: Comparison with observations (observable counterparts, though theorists care little about them)
The roof: Close binary evolution and all the rest.
Tutorial: Photometric appearance of interacting close binaries.

Dr. Joseph Silk

Galaxy Formation

1. From density fluctuations to galaxy halos
* Introduction to dark matter.
* Matter power spectrum, linear growth, nonlinear growth, epoch of galaxy formation, number density of halos.
2. The role of baryonic dissipation and the first stars
* Introduction to baryonic matter.
* Dissipation, smallest galaxies, most massive galaxies, clusters, intergalactic matter.
* First stars, reionisation, chemical evolution.
3. Formation of disk galaxies and ellipticals
* Introduction to normal galaxies.
* Disk instability and star formation. Mergers and starbursts. Galactic outflows and active galactic nuclei

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Dr. Martin Hendry

Statistical Astronomy

In many areas of astrophysics the application of advanced statistical methods to analyze very large data sets is playing an increasingly important role. Recent observational developments in cosmology, for example, supply a wealth of new data (from e.g. galaxy redshift surveys, distant supernovae and the cosmic microwave background radiation) of unprecedented quality and quantity. These data sets can in principle place powerful constraints on the parameters of cosmological models, but their analysis presents an enormous computational challenge. Sophisticated new statistical tools are, therefore, being applied to compress and characterize very large data sets, and compare them to theoretical models via quick and efficient searches of multidimensional parameter spaces.
The aim of these lectures will be to summarize recent developments in the analysis of very large astrophysical data sets, highlighting the powerful statistical tools which are now available and providing a series of concrete examples of their application. The main topics to be covered are as follows:
1) Setting the context: why does astrophysics need advanced statistics?
2) Mathematical building blocks: an introduction to probability theory
3) Statistical building blocks: sampling theory, parameter estimation and the principle of maximum likelihood
4) An introduction to Bayesian inference: prior and posterior probability, Bayesian evidence and model election
5) Bayesian and non-Bayesian hypothesis testing
6) Dealing with observational selection biases
7) Data compression methods, including principal component analysis
8) Searching multidimensional parameter spaces: Markov Chain Monte Carlo sampling
9) Robust methods: inference with minimal model assumptions
10) Current and future applications: from accelerating universes to measuring gravitational waves

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Dr. Pedro G. Ferreira

Cosmology with the Cosmic Microwave Background

Cosmology is the focal point of modern physics, with the interplay of mathematics, physics and astronomy. It allows for extreme speculation but also requires stringent predictions to be compared to precise experimental facts. The cosmic microwave background, the relic radiation left over from the early universe supplies us with a clean observable, which can link physical processes when the universe was a fraction of its age, to high precision, high resolution observations. In these lectures I will

develop the physics of the cosmic microwave background, describe the mathematical tools one must use to make accurate predictions and the statistical tools necessary to compare it to data. I will discuss what we currently know about the state of the universe from the existing data.

Dr. Mariano Mèndez

High-Energy Astrophysics

I will briefly review the emission mechanisms that are relevant in producing the continuum X-ray/Gamma-ray part of the electromagnetic spectrum: Bremsstrahlung, Synchrotron, and Inverse Compton. I will then discuss the most salient aspects of the X-ray emission from collisionally ionized and photoionized plasmas. All these concepts will be used to understand the spectra of X-ray emitting sources, like X-ray binaries, active galactic nuclei, and clusters of galaxies. I will show how to use current software to analyze X-ray spectra; the students themselves will use this software to fit the X-ray spectrum of a cluster of galaxies observed with XMM-Newton. They will be able to extract temperature and chemical abundance gradients. Finally, I will review the importance of variability in the X-ray domain in studying neutron stars and black holes.

Dr. Edward Guinan

Magnetic Activity of the Sun and Solar type Stars

* Introduction to the solar and stellar magnetic dynamos
* Possible effects of Solar Magnetic Activity on the Earth's Climate
* Nuclear Evolution of the Sun and the Effects on Earth's Climate
* The Study of Solar Analogs —The Sun in Time Program
* Learning about the young Sun's X-UV Fluxes from young dG stars
* The active young Sun and the effects of the young Sun's Strong X-UV emissions and solar winds fluxes on the planets.
* How the Young Sun's Strong Magnetic Activity produced major changes in the atmospheres of the terrestrial planets (for example- Loss of water on Mars and the evolution of Life on Earth)
* Effect of Stellar magnetic activity on Extrasolar Planets
* Ideas for research programs for ISYA participants

Variable and Eclipsing Stars as Astrophysical Laboratories

* Fundamental stellar quantities from the study of eclipsing binaries, examples include:

+ Stellar masses and diameters,
+ Internal structure of stars from apsidal motion studies,
+ Testing general relativity,
+ Detecting low mass companions and planets from the light travel time effect,
+ Calibration of the extragalactic distance scale using extragalactic eclipsing binaries,
+ Transit eclipses from exosolar planets (illustrated with examples)

Other activities

* Possible research ideas for ISYA participants
* Neat programs that can be done with small telescopes or with no telescopes (using photometry archives);
* Collaborative programs for ISYA partipants.
* Taking advantage of NASA's and ESA's rich archival data bases with examples.
* Informal Discussions and Advising on Writing Effective Resumes and Strong Research Proposals; and Employment Opportunities in Astronomy and Astrophysics.

Dr. Michèle Gerbaldi

Stellar Atmospheres and Data Analysis

The guidelines of these lectures are:
* Why stellar observations ?
* Tools to interpret the observations,
* Interplay between observations and theories.

These lectures will insist upon some facts concerning the stellar astrophysics, not only how the parameters which describe the stars can be measured but also what really are we measuring due to the fact that between the detector and the star there are: the interstellar medium, the earth atmosphere and finally the telescope.
The emphasis will be put on the use of the archives of the observational data available from most of the observatories, whatever their localization is, and from the space experiments.
The physics of stellar atmospheres will be described as well as the methods used to compute a "synthetic" stellar spectra which in turn allows the determination of the photospheric chemical composition.
Examples of the methods currently used to analyze the structure of a stellar atmosphere will be developed in the framework of the determination of the abundances of some key elements for stars of various ages, in order to frame the metallicity of our Galaxy.

Dr. Kavilan Moodley

Cosmological Models

My tutorials would develop on computational and statistical techniques, not the processing of raw data, but using processed data to tie up with cosmological models. Examples of this include using the Hubble data to derive the value of the Hubble parameter (with an analysis of systematic and statistical errors) and using the Type 1a supernovae data to determine the acceleration rate of the universe. A more computational-type tutorial on the physics of the CMB can be done using CMB fast. The basic idea of these tutorials would be to tie the observations to theory.

Dr. Ignasi Ribas

Astronomical techniques

The main theme of my lectures will be the analysis of astronomical data and the use of databases. More precisely, I plan to discuss general concepts on astronomical techniques (astrometry, photometry and spectroscopy), including the effects of the interstellar medium and Earth's atmosphere. Modern optical/near-IR detectors, such as CCD cameras, will be covered with detail. Here I will explain the basic operation of a CCD device and discuss their advantages and shortcomings. To complete this instrumental part, I will briefly describe how astronomical data reductions proceed, with focus on each of the steps involved in the preliminary processing and the extraction of scientifically useful data.

Along this same lines, I plan to devote some time to discuss the importance of astronomical databases, their exponential growth, and the crucial role they will play in the near future. The flourishing wealth of public astronomical data constitutes a great resource for scientists in countries that have no direct access to world-class observatories. Examples of currently existing (MAST, VLT, HEASARC, 2MASS) and future databases (SDSS, GAIA, Planck, etc) will be given.

Practical sessions are planned to illustrate the concepts discussed. In one case, raw CCD observations of the open cluster M67 will be provided, together with the necessary calibration data. The students are expected to carry out all the steps of the reduction and analysis with the aid of IRAF, a suite of custom programs and the help of public databases. The goal of this session is the construction of a color-magnitude diagram and the determination of cluster parameters such as its age, reddening, distance and metallicity.

The other practical session will focus on spectroscopy of binary stars. In this case, the students will be provided with several high-quality double-lined spectra to measure line positions with IRAF. Then, by using a catalog of spectral lines they will calculate the radial velocity shifts of the components. The star's fundamental properties follow from the fit of the radial velocity curve. Finally, to illustrate the use of ultraviolet

data, the students will request and download public spectra from HST and measure radial velocities. This will also illustrate the complications added by low signal-to-noise data.

Dr. Mohammed Badaoui

Infrared High Resolution Molecular Spectroscopy

Lecture 1:
An Introduction to Infrared High Resolution Molecular Spectroscopy

1. Classical Mechanic Energy of Rotation-Vibration of Molecules, Group Theory, and Molecular Symmetry.

2. Quantification of Rotation-Vibration Energy of Molecules, Quantum Hamiltonian and Infrared Spectra.

3. Resonances: Interaction between rotation-vibration energy levels.

4. Nomenclatures, Blass' relations and assignment of experimental spectra

5. Programm ing of matrix elements in wave functions standard base for C3V symmetrical type molecules as CH3X (X = Cl , Br, F)...etc.

6. Least Squares method to determine parameters of the Hamiltonian. The finger prints of molecules. Applications.

7. An example of Calculation: Determination of parameters of 2n3 parallel band of CH379Br around 1214.7 cm-1 using a Fortran source code.

Lecture 2:
Lines Parameters Measurement in Infrared Spectra recorded by Fourier Transform Spectroscopy

This lecture presents Michelson's Interferometer or what we call Fourier Transform Spectrometer (FTS) that produces signatures of molecules in the infrared range for many purposes and especially atmospheric and astrophysics ones. We show that raw data obtained by the FTS are convoluted with the apparatus function of the instrument. Afterwards, we discuss about a method devoted to the measurement of line parameters: position, intensity, collisional width and positions shifting. More specifically, the method takes into account the influence of the throughput, of the phase error and of the channeling caused by internal multiples reflections.

* The method has been applied to the treatment of HNO3 gas allowing one to generate improved line parameters which should be useful to produce its synthetic spectra or its infrared finger print. The unstable gas HNO3 is harmful for the terrestrial environment for it causes acid rains. The HNO3' rotation-vibration bands considered in this lecture are v5 and 2v9 (896 cm-1), v3 and v4 (1334 cm-1).

* Voyager 1 infrared (IRIS) spectra of Titan in 200-1400 cm-1 spectral region will be displayed and discussed.
