REPORT ON THE FIRST ADVANCED CHILEAN SCHOOL ON ASTROPHYSICS

"EXTRASOLAR PLANETS AND BROWN DWARFS"

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ORGANIZED by D.Minniti (PUC), D.Alloin (ESO), MT.Ruiz (UChile), G.Pietrzynski (UConcepcion), and sponsored by the FONDAP Center for Astrophysics, European Southern Observatory, Princeton/ Catolica Universities, Fundacion Andes, SOCHIAS, and NRAO, the goal of this series of Schools (http://www.astro.puc.cl/ ~school/) is to train the young generation of astronomers on different topics. The School format has been chosen in order to allow a deep approach of the selected themes, as well as to maximize exchanges between the invited lecturers and the attendees.

For this School on Extrasolar Planets and Brown Dwarfs, held in Santiago on 15-19 December 2003, the four main lecturers were (see photo): Jill Knapp (UPrinceton), Michel Mayor (UGenève), France Allard (ENS Lyon), and Scott Tremaine (UPrinceton).

Since the mid-90s, the field of brown dwarfs and extrasolar planets has bloomed in a spectacular fashion, both on the observational side and on the modeling side. Rather than report on all the advances beautifully presented at the School, let us examine some of the points which remain in the to-do lists shown by the different lecturers.

First of all, we shall stick, for the time being, to the definition adopted by the IAU:

• "star": mass above 80 M_{Jup}, H-burning core

• "brown dwarf": mass between 80 and 13 M_{Jup}, D burning core, large variation of the surface temperature from an M dwarf (3,000 K), to a T dwarf(< 1,300 K)

• "planet": mass less than 13 M_{Jup}

One notices that this definition is not linked to the object formation scenario.

The number of objects known so far are: about 120 planets (at distances up to 30 pc) and about 400 brown dwarfs (at distances up to 200 pc).

On the front of observing:

• Brown dwarfs: Jill Knapp and other contributors at the School reported that it is a "tough job" to find them (intrinsic luminosity less than $2{\cdot}10^{-6}$ solar luminosity and $(V\text{-}K) \sim 10$). Exploiting the all-sky surveys available today, more than one million objects have been searched for: only 60 L dwarfs have been found... Good progress has been made in the M/L/T brown dwarf classification (on the basis of their spectra).

To-do list: increase the sample of brown dwarfs, to test models, make a proper motion survey in the NIR, formation scenario: ascertain the low mass end of the stellar IMF, the relation planets = brown dwarfs?

• Extrasolar planets: Michel Mayor and other contributors reported that it is as well a "tough job" to find planets (light contrast star/planet around $10^{10,}$ request for 1 m/s velocity precision). Radial velocity searches have so far provided all known planets (~120), except for one. About 2000 stars in the solar vicinity are currently monitored (at distances less than 30 pc). Among the 120 known planets, 10 are multiple planet systems.

The use of other methods for planet discovery, such as transit, reflected light, microlensing, etc... is in progress.

To-do list: understand the amazing dependence on the metallicity of the parent star, investigate the brown dwarf desert and investigate its implications on the formation scenarii, increase the sample of known planets up to 10^4, so that statistical properties can be derived with some confidence: at the current rate of planet discovery (about 10/year), this will take 10^3 years!! Can we wait that long?

It was also extremely interesting to hear about intrinsic limitations in planet searches: accoustic modes of the parent stars, spots of the parent stars, and in the case of multiple planet systems, the difficulty in finding a unique solution in the decomposition of the radial velocity curve.

• Of course, a wealth of groundbased and space tools for discovering planets and brown dwarfs were discussed (incomplete list!): HARPS (1m/s precision), optical and NIR interferometry, adaptive optics -in the future multi-conjugate adaptive optics, COROT, KEPLER, ALMA for protoplanetary discs, SIM, GAIA, GEST, OWL and ELTs in general.

On the front of modeling:

• The atmospheres of brown dwarfs were extensively discussed by France Allard. They are rather well understood and modeled (thanks, among other factors, to the tremendous increase in computational power).

To-do list: improve the opacities, consider more realistic dust grains (composition, shape)

• Dynamics, kinematics, formation scenarii: a large panel of fascinating problems were discussed by Scott Tremaine and other contributors at the School..

To-do list (a subset...): elucidate the "mystery" of the planetesimal growth from cm size to km size, understand the physics hidden in the term "viscosity" in protoplanetary discs, understand the "peculiarities" of the Solar system: its ellipticity, the location of Jupiter, the origin of chondrules, formation scenarii: collapse versus coagulation of planetesimals.

• Some other interesting questions concerning the modeling of planetary systems were raised: are closed-box models valid? Given that half the mass of the Solar system is in small bodies, taking into account only massive planets to study the dynamics of planetary systems might be misleading; how to disentangle evolution (such as planet migration) from intrinsic properties?; what is the role of star multiplicity in the formation of planetary systems?; which is the fraction of lost planets?

In conclusion, an enlightening School, which took place in the grounds of the Observatory of Cerro Calan in the heights of Santiago. About 80 attendees (more than half of them from South America) enjoyed the lectures, the discussions in the shadow of the trees, and contributed to the friendly atmosphere. Finally, the School dinner at Casa Piedra allowed everyone to admire a beautiful sunset on the rio Mapocho.