



EUROPEAN COMMISSION
RESEARCH DG HUMAN RESOURCES
AND MOBILITY

EXT Periodic Activity Report

Project No.: 14265

Project Acronym: CIFIST

Project Full Name: Cosmological Impact of the First Stars

Marie Curie Actions

EXT Periodic Activity Report

Period covered: from 01/09/2005 to 31/08/2006

Date of preparation: 30/09/2006

Period number: 1st

Start date of project: 01/09/2005

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Project coordinator name:
Dr. PIERCARLO BONIFACIO

Duration: 48

Project coordinator organisation name:
Observatoire de Paris

Version: 1

Marie Curie Actions

EXT Periodic Activity Report

GENERAL INFORMATION

Project No.:	14265
Project acronym:	CIFIST
Project full name:	Cosmological Impact of the First Stars
Period number:	1st
Period covered - start date:	01/09/2005
Period covered - end date:	31/08/2006
Project start date:	01/09/2005
Project duration [months]:	48
Project coordinator name:	Dr. PIERCARLO BONIFACIO
Project coordinator organisation name:	Observatoire de Paris
Date of submission:	30/09/2006

SUMMARY OF THE RECRUITMENT DURING THE REPORTING PERIOD

Contractor: Observatoire de Paris

Name of the Researcher (as stated at time of selection)	Type	Origin		Gender	Start date of recruitment	End date of recruitment	No. of full-time equivalent months covered by this recruitment during the reporting period
		Country	LFR				
Hans-G. Ludwig	ER (> 10 years)	DE-Germany	No	Male	01/09/2005	31/08/2009	48
Jonay Gonzalez Hernandez	ESR (<4 years)	ES-Spain	Yes	Male	01/09/2005	31/08/2009	48

GENERAL PROGRESS OF THE PROJECT

Please indicate if the project

a) is, at this stage, being implemented as originally planned

If you answered b) or c) please include a detailed description of the modifications in the report (one page)

Qualitative indicators of progress and success

On September 8th 2005, the CIFIST Team organized a kick-off meeting at the Observatoire de Paris. The participants of the meeting were staff of the Observatoire (astronomers, administrative, technical), including the President (Dr. D. Egret) the two Vice-Presidents (Dr. C. Stehle' and Dr. C. Zeppen) and the Director of the hosting Department (GEPI, Dr. F. Hammer) as well as the Project Officer, Dr. N. Deliyannakis. This kick-off meeting was the first milestone of the project, as mentioned in the contract Annex I section 6.2. It turned out to be very useful as it provided a clear snapshot of the conditions under which the Team began to operate and allowed for an efficient planning of the Team activities. The meeting is summarized in the Initial Outline Report, written by the Team Leader and delivered on September 30th. The Report is available world-wide through the Team's web page <http://www.galax.obspm.fr/CIFIST> . In Annex I of the contract it is stated that within the first 14 months the Team members will have submitted at least 1 paper to a refereed journal, as a matter of fact up to August 31st 2006, the number of papers submitted to refereed journals by Team members is 10, of which 5 already accepted.

PROJECT ACHIEVEMENTS

Scientific highlights

The Team has started very swiftly its activities which we may divide in 4 main lines:

1) Observing proposals to secure data to be exploited in the course of the project: we submitted proposals to the European Southern Observatory and the Telescopio Nazionale Galileo, and were quite successful, in spite of the high pressure on these facilities.

Accepted proposals ESO period 77

1. 277.D-5031 Zaggia/ Bonifacio/ Ludwig/ Cayrel/ Beers Searching for Metal Poor Stars in Sloan Fields: characterizing and calibrating the WFI filter ESO#865 as a preliminary step towards a Pilot Survey. 2.2m+WIFI 4.5h
2. 077.D-0299 Bonifacio et al. The ultra-metal-poor end of the lithium plateau UT2 8.2m+UVES 16h
3. 077.B-0507 Pasquini et al. Disclosing the early formation of the Galaxy through $[\alpha/\text{Fe}]$ -Be diagnostic UT2 8.2m+UVES 26h
4. 077.D-0246 Pasquini et al. Lithium-Oxygen correlation in Turnoff stars and the formation of Globular Clusters UT2 8.2m+FLAMES 27h

Accepted proposals TNG AO 13

44. The ultra-metal-poor end of the lithium plateau TNG 3.5m+SARG 18h

Accepted proposals ESO period 78

1. 078.D-0217 Ludwig/ Bonifacio/ Caffau/ Cayrel/ Gonzalez Hernandez/ Hill/ Molaro/ Spite/ Spite Extremely metal-poor dwarf stars in the Sloan Digital Sky Survey UT2 8.2m+UVES 29h
2. 078.B-0238 Spite et al. The Early stages of Galactic evolution: the problem of the Nitrogen enrichment UT2 8.2m+UVES 3 nights

2) Search of metal-poor stars. Extremely metal-poor stars, the study of which constitutes the core science of the Team, are very rare and their identification requires dedicated surveys and sophisticated analysis strategies. We have decided to start the exploitation of the substantial amount of data available through the Sloan Digital Sky Survey (<http://www.sdss.org/>). Our approach has been in two separate and complementary directions: on the one hand we developed a special technique, implemented with a computer code, to estimate the metallicities of the dwarf stars from the SDSS spectra (low resolution $R \sim 2000$, but large spectral coverage), on the other hand we undertook a thorough theoretical study of the properties of the SDSS photometric system, in order to understand how it may be used to identify extremely metal-poor stars. The analysis of the spectra was very successful, it allowed to detect about 20 candidates with estimated metallicity $[\text{Fe}/\text{H}] \leq -3.0$, 15 of these are observable from the ESO Paranal site and proposal 078.D-0217 is aimed precisely at obtaining high resolution spectra for these stars to determine accurate metallicities and elemental abundances. For the stars which are too northern to be observed from Paranal we submitted a proposal this September to observe them with Keck+HIRES from Mauna Kea. We stress that the candidates have V magnitudes in the range 16-17 and are too faint to be observed on 4m class telescopes. As a by-product of our search, the analysis of the SDSS spectra provides a good picture of the low metallicity tail of the Halo metallicity distribution and a paper to present this result is in preparation.

The theoretical study on the SDSS photometric system showed that metallicities can be estimated from the photometry in the 5 SDSS filters, with an accuracy of the order of 0.3 dex, at least for dwarf stars. But only down to a metallicity of -2.0, at most -2.5 (depending on effective temperature). At lower metallicities the sensitivity of broad-band colours saturates. We have therefore sought to complement the SDSS photometry with a single narrow band filter to be able to perform metallicity estimates at least down to -3.5. After rather extensive theoretical investigation of several potential possibilities we concluded that the only effective choice is a narrow band filter centered on the CaII K line. A suitable filter exists (ESO#865) on the Wide Field Imager on the ESO/MPI 2.2m telescope. The filter has hardly ever been used and it is not yet clear if it is possible to calibrate it with the desired accuracy. We therefore obtained time to observe standard stars with this filter and attempt to calibrate it, if this effort is successful we plan to propose a wide-field survey in this filter covering a substantial fraction of the SDSS footprint. At the same time we have undertaken an effort for a proper calibration of the theoretical SDSS colours which we computed. To this end we have acquired high

resolution spectra of the SDSS primary standards and we shall perform a fine analysis in order to have well defined parameters for these stars, this will allow a verification of the zero points of the synthetic photometry. This effort is done in collaboration with the SDSS consortium which has now undertaken the SDSS-II SEGUE survey. Thanks to this collaboration we should be able to obtain access for part of the SEGUE data in advance of the public release.

3) Analysis of high resolution spectra already available, part of the "First Stars" project legacy. The analysis of all the dwarf stars has been completed, a paper on metallicities and lithium abundances has already been submitted. The analysis of carbon-enhanced dwarf stars in the sample has been completed and a paper already accepted. Carbon isotopic ratios and nitrogen abundances from the NH band have been measured for all the giant stars and a paper on this has already been published. In collaboration with S. Andriewsky (Odessa Observatory), who visited the Observatoire de Paris for three months, the effects of departures from local thermodynamic equilibrium on sodium have been investigated. The main result is that much of the scatter which was seen before and most importantly the apparent differences between dwarfs and giants, have been removed. A paper on this is in preparation and should be shortly submitted to A&A. The binary system CS 22876-32, for which we have high quality, multi-epoch, spectra is being accurately studied, a new and improved orbital solution has been derived and the abundances of many more species, than previously possible, have been measured. A paper on this is in preparation and will probably be submitted before the end of the year.

4) 3D model atmospheres and synthetic spectra. A considerable effort has been done in order to improve the model atmosphere and line formation codes. In particular a new method to compute the effect of stellar rotation in a 3D computation has been devised and implemented. The method will be fully described in one of the forthcoming papers. An application has been submitted to the Italian supercomputing centre CINECA and 10000 hours computing time to compute about 10 models for metal-poor stars have been awarded, the computational effort is underway. A very important validation of the models is the study of the solar spectrum and determination of solar photospheric abundances. The PhD student E. Caffau, under the supervision of H.-G. Ludwig has undertaken a new determination of the solar oxygen abundance, a topic which is currently hotly debated. This showed that the CO5BOLD solar model can satisfactorily reproduce the line shapes in the solar spectrum, the derived solar oxygen abundance is 8.70 or 8.73, depending on what is the assumed role of the collisions with neutral hydrogen on ionization and excitation. This result has been so far presented as a poster paper at two international conferences and presented by one of our collaborators (M. Steffen, Potsdam) at the General Assembly of the International Astronomical Union; a full paper for A&A is being written and will be shortly submitted.

In addition all the Team members have been encouraged to devote a small part of their time to independent research on topics of their choice, even outside the core science of the CIFIST project. This included (but is not limited to), study of the atmospheres of M dwarfs, abundances in X-Ray binaries, cataclysmic variables, micro-variability of solar-like stars, cosmological variation of the fundamental constants, scientific drivers for the extremely large telescopes. This ensures that the Team members keep in touch with the astronomical community at large and maintain a broad scientific interest.

Teaching and training activities

One of the team members (H.-G Ludwig) has undertaken supervising the PhD thesis of a student of the Observatoire de Paris (E. Caffau), the title of the thesis is: "Abondances des elements dans les etoiles pauvre de metaux dans les atmospheres hydrodynamique 1D, non ETL"

There has been an agreement with the Niels Bohr Institute (Copenhagen) and a student (Camilla Juul Hansen) will arrive at the beginning of October to spend three months under the supervision of P. Bonifacio to work on her master thesis.

P. Bonifacio has taken part in the cycle of conferences for the public organized by the Observatoire, "mercredi de l'Observatoire", and delivering a talk on the topic "la science avec les ELTs"

Dissemination of results

All three members of the Team have been very active in participating conferences during which they delivered 6 invited talks.

Attended conferences

1. Probing Early Structure Formation with Mass, Light and Chemistry , Minneapolis, October 6-9, 2005 (P. Bonifacio, invited talk)
2. The Metal Rich Universe La Palma, Canary Islands, 12-16 June 2006 (J. Gonzalez Hernandez, poster paper)
3. CO5BOLD Workshop 2006, Freiburg, Germany, 12-14 June 2006 (H.-G. Ludwig 2 invited talks)
4. The First Stars and Evolution of the Early Universe, Seattle June 19 to July 21, 2006 (P. Bonifacio, invited talk)
5. Chemodynamics, from first stars to local galaxies, Lyon July 10-14, 2006 (P. Bonifacio, invited talk)
6. IAU General Assembly, Symposium 238, Black holes: from stars to galaxies, Prague, 21-25 August 2006. (J. Gonzalez Hernandez, contributed talk)
7. IAU General Assembly, Symposium 239, "Convection in Astrophysics", Prague, 21-25 August 2006 (H.-G. Ludwig, invited talk)

In addition team members have been invited to issue 6 talks during visits at other institutions: University of Victoria, Washington University, Michigan State University, Osservatorio Astronomico di Bologna (P. Bonifacio), Observatoire Midi Pyrenees, Sterrekundig Instituut Utrecht (H.-G.-Ludwig)

List of accepted papers on refereed journals

1. Ludwig, H.-G. Hydrodynamical simulations of convection-related stellar micro-variability. I. Statistical relations for photometric and photocentric variability *Astronomy and Astrophysics*, 445, 661-671 (2006)
2. Gonzalez Hernandez, J. I., Rebolo, R., Israelian, G., Harlaftis, E. T., Filippenko, A. V., Chornock, R. XTE J1118+480: A Metal-rich Black Hole Binary in the Galactic Halo *Astrophysical Journal*, 644, L49-L52 (2006)
3. Spite, M., Cayrel, R., Hill, V., Spite, F., Francois, P., Plez, B., Bonifacio, P., Molaro, P., Depagne, E., Andersen, J., Barbuy, B., Beers, T. C., Nordstrom, B., Primas, F. First stars IX - Mixing in extremely metal-poor giants. Variation of the $^{12}\text{C}/^{13}\text{C}$, $[\text{Na}/\text{Mg}]$ and $[\text{Al}/\text{Mg}]$ ratios *Astronomy and Astrophysics*, 455, 291-301 (2006)
4. Sivarani, T., Beers, T. C., Bonifacio, P., Molaro, P., Cayrel, R., Herwig, F., Spite, M., Spite, F., Plez, B., Andersen, J., Barbuy, B., Depagne, E., Hill, V., Francois, P., Nordstrom, B., Primas, F. First stars X. The nature of three unevolved Carbon-Enhanced Metal-Poor stars, *Astronomy and Astrophysics*, accepted, arXiv:astro-ph/0608112-(2006)
5. Ludwig, H. -G., Allard, F., Hauschildt, P. H. Energy transport, overshoot, and mixing in the atmospheres of M-type main- and pre-main-sequence objects *Astronomy and Astrophysics*, accepted, arXiv:astro-ph/0608264-(2006)

Non-refereed publications

1. Kucinkas, A., Ludwig, H.-G., Hauschildt, P. H. Convection and observable properties of late-type giants, *IAU Symposium*, 232, 498-501 (2006)
2. Homeier, D., Ludwig, H.-G., Allard, F., Hauschildt, P., Dehn, M. Dust in the atmospheres of brown dwarfs and young planets: the effects of gravitational settling and convective overshoot, *IAU Symposium*, 232, 328-328 (2006)
3. Kucinkas, A., Hauschildt, P. H., Ludwig, H.-G., Brott, I., Vasevicius, V., Lindegren, L., Tanabe, T., Allard, F. Photometric colors of late-type giants: theory versus observations *IAU Symposium*, 232, 276-277 (2006)
4. Marconi, G., Sbordone, L., Bonifacio, P. The exotic chemistry of the Sagittarius dSph *Revista Mexicana de Astronomia y Astrofisica Conference Series*, 26, 182-(2006)
5. Sbordone, L., Bonifacio, P., Marconi, G., Zaggia, S., Buonanno, R. The chemistry of the neighbors: detailed abundances in the Sgr and CMa dwarf galaxies. *Memorie della Societa' Astronomica Italiana*, 77, 182-(2006)
6. Pasquini, L., Cristiani, S., Dekker, H., Haehnelt, M., Molaro, P., Pepe, F., Avila, G., Delabre, B.,

D'Odorico, S., Liske, J., Shaver, P., Bonifacio, P., Borgani, S., D'Odorico, V., Vanzella, E., Bouchy, F., Dessauges, M., Lovis, C., Mayor, M., Queloz, D., Udry, S., Murphy, M., Viel, M., Grazian, A., Levshakov, S., Moscardini, L., Wiklind, T., Zucker, S. CODEX: measuring the acceleration of the universe and beyond, IAU Symposium, 232, 193-197 (2006)

ADDITIONAL INFORMATION

Please indicate any additional information, which may be considered useful to assess the work done during the reporting period. The socio-economic aspect of the project may be addressed in this section.

Attachments	
Name	
Date	
Signature	