SF2A 2006
D. Barret, F. Casoli, T. Contini, G. Lagache, A. Lecavelier, and L. Pagani (eds)

THE NEW SOPHIE EXOPLANETS CONSORTIUM: SEARCH AND CHARACTERIZATION IN THE NORTHERN HEMISPHERE

B. Loeillet[1], F. Bouchy[2], S. Udry[3], C. Moutou[1], X. Delfosse[4], A.-M. Lagrange[4], D. Queloz[3], J.-L. Beuzit[4], X. Bonfils[4], R. Da Silva[3], M. Desort[4], T. Forveille[4], F. Galland[4], G. Hébrard[2], C. Lovis[3], M. Mayor[3], F. Pepe[3], C. Perrier[4], F. Pont[3], D. Segransan[3], J.-P. Sivan[1] and A. Vidal-Madjar[2]

Abstract. The advent of the new SOPHIE spectrograph at the Observatoire de Haute-Provence (OHP) 193cm telescope takes place in the short list of the high precision spectrographs after 15 years of planet searches with ELODIE. A consortium has been established gathering 22 members from Geneva, Paris, Grenoble and Marseille exoplanet teams. The objectives are to characterize the zoo of exoplanets and to bring strong constraints on their processes of formation and evolution using the radial velocity technique. An observational proposal over 110 nights per semester has been submitted to cover efficiency all the crucial aspects of exoplanetary science extending the sample of known exoplanets over a large range of primary star parameters.

1 Introduction

Many significant breakthroughs have been completed on exoplanet detection and characterization these last years, in most part thanks to Doppler measurement improvements illustrated in particular by the HARPS spectrograph (ESO 3.6m, La Silla, Lovis et al. 2006). Based on a similar principle of operation, the new SOPHIE spectrograph (OHP 1.93m, Bouchy et al. 2005) will satisfy three main improvements, compared to ELODIE: a high radial velocity precision (1 to 2 m s^{-1} expected), a high and an intermediate resolution mode and a 3 magnitude efficiency gain. With these characteristics the SOPHIE spectrograph will strongly contribute to the exoplanetary science. Moreover SOPHIE has led to detect 2 new exoplanets the first nights of observation (Collier Cameron et al. 2006, astro-ph/0609688). A French-Swiss consortium, led by F. Bouchy, has been established gather 22 members from the exoplanet research teams of Paris, Grenoble, Marseille and Geneva. The Exoplanet SOPHIE consortium wish to realize an ambitious and competitive scientific program for the search and characterization of exoplanets.

2 A large scientific program

The scientific program of the consortium covers a large part of the exoplanetary science. Its objectives are multiple and consist in bringing constraints on the formation and evolution processes of the planetary systems and to characterize these objects. By reaching these goals, the program will allow the analysis of different aspects, as 1) the determination of the mass function of the low-mass exoplanet population, 2) enlarging the exoplanet sample in order to bring strong constraints on the formation and evolution models, 3) the study of the links/relations between the exoplanets and the physical and chemical properties of their parent stars, 4) the characterization of the mass and radius of the transiting exoplanets, and 5) the detection of exoplanets around nearby stars, allowing space and ground-based follow-up. All these aspects will be treated through 5 scientific sub-programs, described below. The relative weight of each subprogram will match the evolving priorities of this “hot” science.

[1] Laboratoire d’Astrophysique de Marseille, Traverse du Siphon, 13376 Marseille, France
[2] Institut d’Astrophysique de Paris, UMR7095 CNRS, Université Pierre & Marie Curie, 98bis Boulevard Arago, F-75014 Paris
[3] Observatoire de Genève, Université de Genève, 51 ch. des Maillettes, 1290 Sauverny, Switzerland
[4] Laboratoire d’Astrophysique de l’Observatoire de Grenoble, BP 53 F-38041 Grenoble Cedex 9, France

2.1 High precision Measurements for "Super-Earth" planets

Only few low-mass exoplanets ($Msini$ < 0.1 M_{Jup}) have been discovered up to now. As illustrated by the recent discovery of a 3 Neptunes planetary system with HARPS (Lovis et al. 2006), the high precision on this kind of objects is critical. With the precision achievable by SOPHIE it becomes possible to detect low-mass exoplanets (Neptune and Super-Earth type) and to bring constraints on the statistical properties (frequency, orbital parameters) of these objects. This program will follow 200 bright (V <8) and non-active ($vsini$ < 3 km.s^{-1}, log R_{HK}< -4.7) stars over 5 years.

2.2 Search and Characterization of Hot Jupiter planets

The second sub-program consists in the continuity of the ELODIE II program, started by S. Udry in 2003. The objectives are to detect hot Jupiters and to significantly increase the sample of transiting exoplanet composed of 14 objects by monitoring about 200 metal-rich stars over 5 years, performing a systematic search for photometric transits, as it was done with HD189733 (Bouchy et al. 2005). The transit events allow us to expect strong inputs to internal structure models and evaporation scenarii.

2.3 Search for Exoplanets around M dwarfs

Until now 3 three planetary systems (Delfosse et al. 1998, Marcy et al. 1998, Rivera et al. 2005) and two unique planets (Butler et al. 2004, Bonfils et al. 2005) have been detected around M dwarf stars. The objectives are to determine statistics of these exoplanetary systems, expected to have a lack of massive planets around M dwarfs (Lin & Ida), and to detect low-mass planets (around 10 M_{Earth}) around M dwarfs stars by monitoring a selected sample of 200 stars. An extension of this program could be to check for transit events of the detected objects (both the Radial velocity and photometric signals are favored by a low-mass primary star).

2.4 Search for Exoplanet host hot stars

Promising recent results (Galland et al. 2005, 2006) led us to extand the survey to more massive dwarfs stars. This program consists in monitoring a sample of "hot" stars (from A0V to F7V) over 3 years and in continuity to the programs on HARPS and ELODIE spectrographs. The objective is clearly to study the influence of the physical properties of the parent star on the formation and evolution process of planets.

2.5 Follow-up of ELODIE long period candidates

This program is the continuity of the historical program started in 1994 by M. Mayor and D. Queloz with ELODIE. By monitoring 40 F and G stars over 5 years, the objectives are first to follow the evolution of very long period planets (beyond 5 UA) and in another part to characterize multi-planetary systems.

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