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The RATS Stellar Fields

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Abstract. RATS is an Italian project devoted to Hot Jupiter search with the transit method. A planet transiting in front of a host star can be mimed by several, and well defined, astrophysical phenomena. In order to recognize these false alarms we can utilize a preventive strategy to limit false alarm rate and a spectroscopic follow up to recognize real transit candidate. As preventive strategy it is important to develop an accurate target field selection, with well defined requisites, in order to maximize the solar type stars number and to minimize the risk of possible astrophysical false alarm. In this paper we describe as the RATS fields selection was done and the obtained results.

Key words. Planets: exoplanets – Planets: transits – Methods:photometry

RATS is a collaboration between several *INAF* Observatories (Padova, Catania, Napoli and Palermo), the Astronomy and Physics Departments of the Padova University and *ESA* in order to search for extra solar planets with the photometric transit technique and spectroscopic false alarm detection. The survey main goal is to find about 10 (20) Hot Jupiter in 5 years exploiting both the 67/92 Schmidt Telescope for photometric transit search and the 182 cm *COPERNICO* Telescope for radial velocity measurements and target characterization.

RATS observing strategy imposes the survey magnitude range. The faintest magnitude is defined by the efficiency of the spectrograph and its radial velocity precision. The brighter magnitude will be a compromise between star counts and the possibility to observe the bright star without saturate the detector. For this reason we de – focalize the Schmidt telescope so that we can observe, with the necessary photometric precision, stars as bright as 9^{th} without CCD saturation and stars as faint as 13^{th} (14^{th}) with an already useful signal to noise ratio.

The major obstacle in the transit search is the large number of astrophysical false alarms (Brown 2003) that can affect the survey. This situation is made worse by the *RATS* observing strategy that impose to have a $10 \div 11$ arcsec telescope defocusing. For this reason we paid attention to the crowding issue in stellar field selection, estimating the number of unpolluted stars. We define unpolleted those stars that have not any catalogue objects within 15

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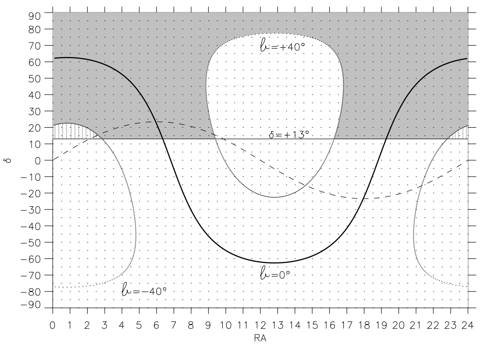

Fig. 1. The sky fraction limited by "geographical" field selection requisites is shown in gray color

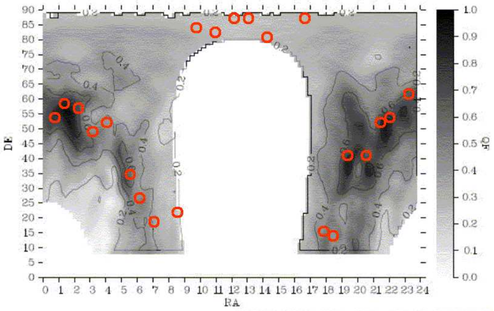

Fig. 2. The selected *RATS* planetary transit search fields distribuited in Right Ascension (red circles)

arcsecs from their center. Therefore we expect that for these stars we can reach the maximum photometric precision.

In addition to maximize the star counts without telescope PSF blend, the next basic criteria will also be follow in the selection of *RATS* stellar fields :

- we search for planetary transit features in light curves of stars with magnitude ranging between the 9^{th} ant the 13^{th} (14^{th})
- in order to have more than eight hour of visibility from the Schmidt location (00^h 46^m 17.3^s East Longitude and $+45^0$ 50 36.2" North Latitude) the field declination will be $\delta \geq 13^0$.
- for galactic latitude greater (lower) than 40^0 (-40^0) the star counts are too low. In order to maximize the star counts we set this value as upper (lower) limit for Galactic Latitude.
- We wish to maximize the FGK dwarf number in the field

Once the sky zone that satisfy to the geometrical requisites (see Figure 1) was limited, we develop an algorythm able to explore one or more catalogue searching for the stellar field that maximize the number of suitable stars. At first, in order to minimize the CPU time, we explore the Tycho Catalogue for one square degree fields. Several fields, almost one for units of Right Ascension (see Figure 2), where selected among those that maximize the merit function:

$$QF = \frac{N}{N_{Max}} \frac{N_{bMax} - N_b}{N_{bMax}}$$

where N is the number of the stars in the field; N_{Max} is the greatest number of stars found among all explored fields, N_b is the number of stars brighter than 9^{th} magnitude and finally N_{bMax} is the number of stars brighter than 9^{th} magnitude permitted in the field without CCD saturation problem and contamination on stars in their neighbourhoods.

Successively the selected fields were confirmed by a re – analysis on more complete catalogues. At present time there are three whole – sky stellar catalogues wich might be appropriate for the confirmation of fields: *2MASS*, *GSC2* and *USNO B1*. *GSC2* and *USNO B1* are created from photographic plate digitalization. For this reason they contain a significant number of spurious objects, and the number of objects in the field is a strong function of the original plate sensitivity. In the EDDINGTON Planet Finding Field selection (Barbieri et al. 2004) we have checked that the limit magnitude of *USNO B1* catalogue seems to be a strong function of the original plate sensitivity. *GSC2* is less affected by these limitations. In particular *GSC2* contains some status flags that allow to classify the objects in the field (stellar or not stellar objects, dimension etc.). On the contrary *GSC2* is not useful for the spectral classification and giant/dwarf classification. So in order to confirm the selection of *RATS* fields we use both *2MASS* and *GSC2*.

Moreover, as an ulterior check, we plan to characterize the selected stellar field with photometric and specroscopic observing campaign.

References

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Barbieri M., et al. 2004, Proc. 2nd *EDDINGTON* workshop, "*Stellar Structure and Habitable Planet Finding", F.Favata, S. Aigrain eds. ESA SP–538, 163*