NEAT workshop

Science Issues

Activity of background reference K giants

(help from B. Mosser, F. Baudin)

Activity of background reference K giants

Impact of photospheric/pulsating activity of the reference stars ?

➡ Reference stars are mostly K giants stars located at a distance of ≈1kpc

- Expected astrometric jitter from stellar pulsations ?
- Expected astrometric jitter from stellar spots ?

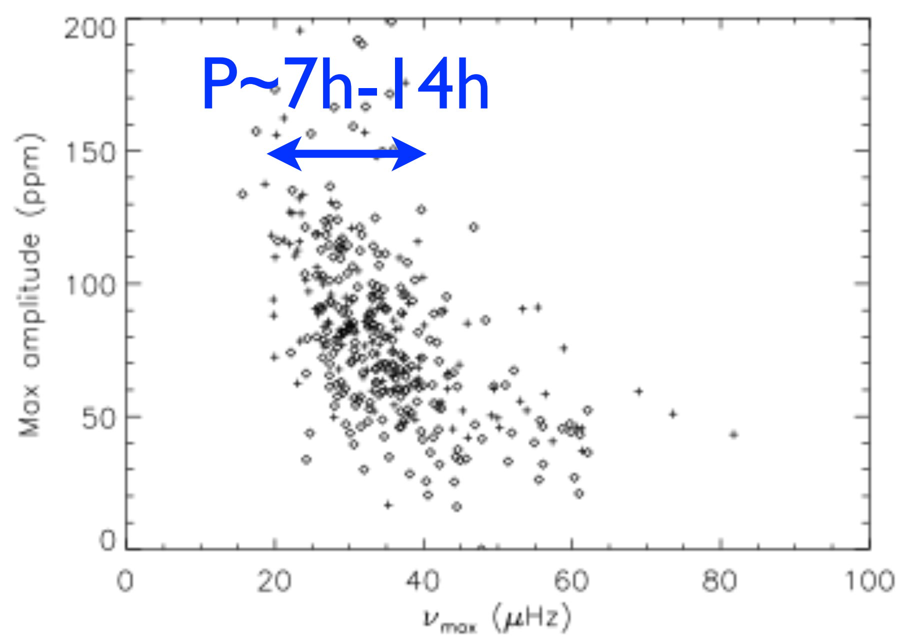
Conclusion : these effect is far below the photon noise of NEAT and far below the spot noise of the target.

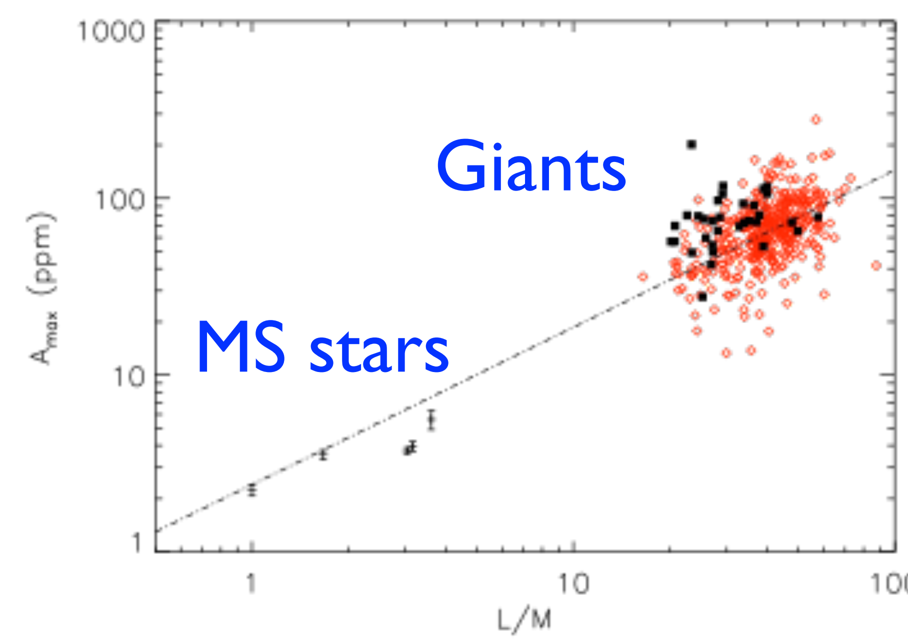
In addition, the reference stars will all be in the GAIA catalog, so we can eliminate stars with photometric variations above 1% using the photometry derived by GAIA whose photometry accuracy is better than 0.1% for stars brighter than V≤14.

Expected astrometric jitter from stellar pulsations ?

- CoRoT and Kepler missions have investigated the activity of these giant stars using astroseismology.
- The pulsation modes are mainly radial for giants near the tip of the red giant branch with no effect on photocenter
- The pulsation modes are mainly dipolar for the giants of the red clump with an impact on their photocenter position.

Baudin et al. (2011, A&A 529, A84)





- Largest amplitudes are in the 20-40µHz domain (P = 14-7h) : it can affect measurements during a visit by NEAT, but that are not correlated for different visits (several weeks).
- The amplitude of such modes is typically 100 ppm and they are about one hundred providing a total amplitude of 1000ppm (quadratic summation).

Expected astrometric jitter from stellar pulsations ? (cont'd)

- The astrometric jitter associated with one dipolar mode is dx = *Rstar* d*F*/*F*.
- For a reference giant star with *Rstar* = 20 Rsun, d*F*/*F* = 100 ppm, at 1kpc, the jitter angle is 0.01µas.
- The jitter corresponding to 100 out of phase modes is 10 times larger, or 0.1µas per visit and per reference.
- In the worse case where the 6 to 8 references are red-clump members, it would give an error of 0.04µas.
- During the total mission (50 visits) the corresponding error is 0.006µas, significantly less than the photon noise of NEAT.

The effect from giant star pulsations is therefore far below the photon noise of NEAT and it was omitted also from the double blind study.

Expected astrometric jitter from stellar spots

- The apparent brightness of the reference star compared to the target star is proportional to the square of their apparent diameter for stars of similar color/effective temperature, which is the case here to a good approximation. So a reference star, which is typically five magnitudes fainter than the target, will have an apparent diameter 10x smaller.

- Another way is to say that the giants are located 100x further (1kpc) than the target, which a solar type star at 10pc, but their physical radius is about 10x the solar radius. Therefore the reference stars have an apparent diameter ten times smaller.

Therefore NEAT measurements can tolerate 10x more star spot jitter on the reference than on the target.

Expected astrometric jitter from stellar spots (cont'd)

- The astrometric jitter due to a single spot is given by $\Delta x \sim \Delta F/F.R_{star}$.
- 0.1% photometric variation due to a spot on a giant star located at 1kpc produces a 0.03μas bias.
- The reference stars are required to have spots with a maximum total flux variation of 1% to fulfill the basic performance of NEAT, 0.3μas per visit.
- Because NEAT uses 8 reference stars, if only 1 of the 8 has a 1% photometric (worse case), this will bias the target position by 0.3μas / 8 ~ 0.04μas.
- If all 8 reference stars have 1% photometric variation, the astrometric bias of the reference frame will be ~0.12μas, still a factor of 3 below the target star's star spot bias which we know is not a problem
- From the CoRoT data, the total photometric amplitude measured is 1000ppm. Again in the worse case where for some stars it would be totally due to the motion of stellar spots, it would be still one order of magnitude less than the critical threshold of 1%.