Hi Rolf,

Here's the material that I have from Jeff. It's from the first MAXAT meeting in Wisconsin several years back, and it is excerpted from other material that Jeff's group discussed at the meeting. If you need to contact Jeff for further info, he's at STScI; his email is valenti@stsci.edu.

Best regards,
Joan

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Jeff Valenti:

Seismology of Solar-Type Stars

Sicentific Motivation: Helioseismology has revealed shortcomings in the standard solar model, which is currently being revised. Seismology of spatially unresolved stars will further revolutionize our understanding of stellar structure, despite being limited to modes of low angular degree. Mode frequencies can be measured to very high precision, even for very distant stars Initial results will be used to improve our understanding of how mode frequencies are affected by stellar mass, composition, age, and differential rotation. Observations will explore how convective and diffusive processes depend on stellar parameters.
Once models become adequate, stellar seismology can be used as a tool to determine very accurate parameters for many systems of interest.

Required Observations: Stellar modes can be diagnosed photometrically or spectroscopically. Intensity variations will be a few parts per million, while velocity perturbations will be 0.1 m/s. Mode periods
range from 3-60 minutes, depending mainly on mean stellar density. Observations over several days (preferably without interruption) are required to resolve adjacent modes, but it might be possible to
determine characteristic frequencies in only a few hours with high S/N. Understanding mode characteristics will require observations of roughly 20 stars per cluster for a few clusters and also about 30 nearby disk and halo stars. Individual stars will require a several hours of observation a night for 1-10 days. The core program would require about 3 months of observing time. Application of the technology to additional systems would require 0.5-5 nights per target. Higher efficiency would be achieved for photometric studies that sample several stars simultaneously. Aliasing could be reduced with a network of at least 4 telescopes distributed around the Earth.

Required Facilities: To measure intensity variations, a 30-m telescope is required to reduce atmospheric scintillation below the expected signal level. Reference stars would be required to monitor telluric

transparency variations. Intensity variations are slightly larger in the blue, but this advantage is offset by lower photon flux. To measure velocity perturbations, very high spectral resolution (R=120,000) over
a wide spectral range is optimal. Atomic line density is biased towards the blue, while molecular lines are easier to detect in the red. For either technique, angular resolution is only important for avoiding source confusion in clusters or close binaries. Ideally, observations would achieve the required precision in under minute, but long time series can partially compensate for lower precision.

Role of MAXAT: Assuming radial velocity seismology requires S/N=300 in a 1 minute exposure, MAXAT extends the range of main-sequence spectral types accesible in nearby clusters: Praesepe (A4V-G2V), Pleiades (A6V-G4V), Coma Berenices (F6V-K1V), and the Hyades (G5V-K7V). Without MAXAT, G5V is the latest spectral type that can be studied in clusters and the Hyades is the only accessible cluster. Based on a simple photon counting argument, MAXAT achieves a photometric precision of 1 part per million in a 1 second sample at V=0. The brightest main-sequence cluster star with a convective surface (F5V in the Hyades) is V=6.7.

Thus, even with MAXAT, phase averaging of long time series will be required to detect the expected photometric variations. In the best case, 10 minutes of data will be required. Assuming 8 hours of monitoring on 2 consecutive nights, stars as faint as V=12 become accesible. For various clusters, this translates into the following spectral type limits: Hyades (M2V), Coma Berenices (M0.5V), Pleiades (K3V), Praesepe (K2V), NGC 752 (G2V), Trapezium (F8V), M 41 (F5V), and M67 (F1V). Because large aperture is required to overcome atmopsheric scintillation, MAXAT would be unique in its ability to measure intensity variations from the ground. There are a few dedicated space missions being planned, but note that a 2.4 meter telescope must observe for an entire year to match the precision obtained by MAXAT in 2 nights. The 2.4 meter would probably have a larger field of view, however.

MAXAT Design Drivers: High sensitivity is required just from a photon statistics standpoint. For photometric monitoring, telescope aperture must be at least 30-m to beat atmospheric scintillation, and field of view is more important than angular resolution. For spectroscopic monitoring, high spectral resolution and excellent point source sensitivity are required, so instrumentation and image quality are the design drivers.