

POST-MEETING SUMMARY solar-stellar variability workshop

8:30am-5:00 pm Wednesday 19th March 2014,
morning of Thursday 20th March

High Altitude Observatory, NCAR,
3080 Center Green Drive
Boulder, CO 80301

Building CG1, Room 3131

Attendees: Tom Ayres, Mausumi Dikpati, Tim Brown, Ricky Egeland, Sarah Gibson, Greg Kopp, Jeff Hall, Jerry Harder, Philip Judge, Christoffer Karoff, Michael Knoelker, Wes Lockwood, Piet Martens, Savita Mathur, Scott McIntosh, Travis Metcalfe, Mark Miesch, Alexei Pevtsov, Joe Plowman, Rich Radick*, Matthias Rempel, Steve Saar, Michael Thompson, Marty Snow, Giuliana de Toma, Martin Woodard; several more locals from HAO.

Invited, not able to attend: Caspar Ammann, Juan Fontenla, Mark Giampapa, Gregory Henry, Mark Rast, Willie Soon

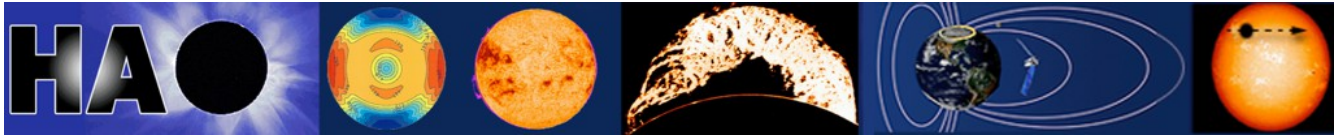
*Attended via video conference

PURPOSE:

The purpose of this meeting was to begin to pool resources to combine data from different instruments including those from the Mt. Wilson epoch (S index) through today (Lowell SSS and Metcalfe S. hemisphere SMARTS survey), with the APT data and Kepler and other relevant and solar datasets. The overriding science goal is to improve our understanding of stellar dynamos, focussing on the Sun in particular. As a secondary goal we aimed to produce a “white paper” outlining the motivations for new funding for solar-stellar research.

It was agreed that we would try to meet again in a year at Flagstaff.

Materials from the meeting are to be found at workshop.solar-stellar.org



Presentations HAO Solar-Stellar variability workshop 19th March 2014

Philip Judge (HAO): Welcome, introductions, and purpose of meeting

Judge reviewed some motivations for understanding solar variability from the point of view of earth's climate and the need to understand the evolving solar magnetic field on decadal-centennial time scales. Casini worried that all that we might find out by studying stars is that "the Sun is an outlier". Given the interest in life on detectable planets outside our solar system, this would constitute an important result all by itself. If the Sun is proven to be typical, stellar ensembles can be used to indicate past and future solar behavior.

Piet Martens (MSU): essential theory

Martens reviewed dynamo models with emphasis on kinematic prescriptions, pointing out basic problems with the paucity of critical data (e.g., internal flows on the Sun) compared with the degrees of freedom available from solar observations. He showed the infamous Bohm-Vitense (2007) figure with the Sun's rotation and cycle period lying in region poorly populated by stars. We were reminded that rapidly and slowly rotating stars have convection patterns that are expected to be different, but this remains an open research area.

Steve Saar (CfA): essential observations

Saar reviewed the observables from ensembles of stars using mostly the proxies (S index,...) to include activity cycle periods, amplitudes, rotation periods, active longitudes, butterfly diagrams, background levels.

Jeff Hall (Lowell): Ca II data from Mt. Wilson and Lowell SSS

SSS observations (Lowell Solar Stellar Spectrograph) began in 1988, rebuilds of instrumentation occurring in 1992-3 and 2008. Solar data are acquired 3x weekly and stellar data acquired 5-7 nights (bright time) per month. Hall highlighted some results from the project – a refutation of the Jastrow and Baliunas result of the S index being bimodal with implications for the Maunder Minimum. Hall reviewed also the published Mt. Wilson data in comparison with SSS, Mt Wilson data up to 2002 exist but some more recent data remain unpublished. A "gap" between 1992 and 1998 can and should be filled by joint analysis of all Mt Wilson and SSS data- scientifically because at least HD 3651 appeared to have entered a non cycling state in 1981 or so, so that the 33 more years of data must be examined; and technically because both the SSS Mt. Wilson time series appear to have issues that require careful cross-examination and calibration (small secular trends in the ensembles of stars on timescales of decades).

Travis Metcalfe (Sp. Sci. Inst): SMARTS Ca II data

Metcalfe discussed SMARTS Southern HK project data which focuses on bright asteroseismic targets as well as observable Mt Wilson stars. He discussed their contributions to our understanding of stellar activity cycles, including a curious phase-jump in the behavior of iota Hor and stars with two activity cycle periods. The SMARTS Southern HK project extended from to mid 2007 to February 2013 when the prime spectrograph was decommissioned.

Alexei Pevtsov (NSO): NSO synoptic data

Pevtsov reviewed data from the Integrated Sunlight Spectrometer (ISS) instrument as part of the SOLIS solar synoptic program at NSO-Kitt Peak. Data are available from December 2006 for 5 of 10 possible spectral bands currently monitored. NSO sun-as-a-star programs (Ca II K line) are available from 1976. Pevtsov also showed how measurements of solar surface fields can allow us to understand time-series data in terms of migration of large regions as well as surface differential rotation.

Wes Lockwood (Lowell) & Greg Henry (Tenn. St.U.): Precision ground-based photometry

Lockwood reviewed the APT program led by Greg Henry at Fairborn Observatory, together with Ca II index data, highlighting both challenges and successes. Quality photometry exists beginning ca. 1990. The earlier APT data tend to have more variable comparison stars. The solar twin 18 Sco and most solar age stars show b-y behavior quite different from the SORCE SIM results of Harder, the b,y and S indices mostly being in phase in stars, but the y index being out of phase in the Sun. Some 30% of the APT stars can currently detect the cyclic variations at the level of 18 Sco, which is somewhat larger than solar. The Fairborn program operates in "single point failure" mode as the hardware is maintained by Lou Boyd alone and the data is processed by Greg Henry alone.

Jerry Harder (CU): SORCE spectrophotometry

Harder reviewed the space-borne SIM instrument, its calibration and essential results- finding spectral variations below 400 nm mostly in phase with the sunspot cycle, but those above this being out of phase. Work continues on calibrations after August 2011 when power constraints forced a new, less stable mode of operation. He also discussed solar variability in terms of earlier published results, PSPT data and extant models of the radiance of various solar features.

Christoffer Karoff (Aarhus U.): Sounding Stellar Cycles with Kepler

Karoff reviewed how asteroseismology reveals the mean density, age and depth of convection zone. Internal differential rotation inferred through seismology is ambiguous, meridional circulation is unattainable. Sun-like stars are not easy to identify in the KEPLER database, those identified being from magnitude 6 to 12. Only 2 Mt Wilson stars are in the Kepler field (16 Cyg A,B). He presented Ca data from ground-based observatories (NOT 2.56m and LAMOST) of these targets. He reviewed the SONG (ground-based) and TESS (space) future missions. From 2014-2016 KEPLER II will obtain spectra of fields including open clusters along the ecliptic.

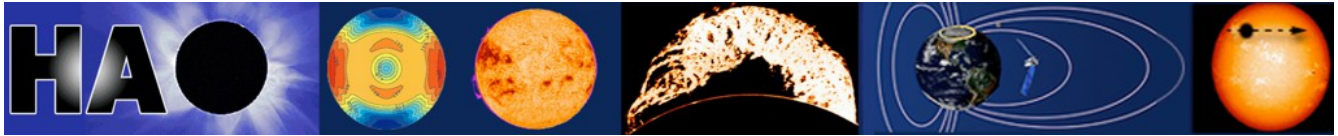
Tim Brown (LCO): Stellar spindown with bimodal dynamos, LCOGT capabilities

Brown reviewed the observed behavior of surface rotation rates versus color in open cluster objects for ages up to 220 Myr, arguing for a metastable dynamo model the essence of which involves a switch in angular momentum loss to a larger (Skumanich) rate at a later time dependent on mass. Several observational tests were proposed. The Las Cumbres Observatory Global Telescope Network will provide medium resolution spectroscopy, first light this year, devoted to time-domain studies by having 1 m class telescopes at some 6-8 observatories distributed in longitude. Such telescopes are well suited to continuing the Mt. Wilson, SSS and SMARTS programs

Mausumi Dikpati (HAO): Flux emergence patterns from recent space observations

Dikpati discussed time-series observations of longitudinal fields at the solar surface drawing distinctions between two observed classes of sunspot formation: coalescence versus buoyant eruption. She speculated about the meaning of these observations in terms of the interior dynamo mechanism(s)

Savita Mathur (Sp. Sci. Inst.): magnetic fields in F stars



DISCUSSION NOTES HAO Solar-Stellar variability workshop 19th March 2014

The discussion proceeded with the following (well known) points in mind:

- The **origins** of large-scale dynamo action are not adequately constrained on the basis of mere solar data alone. (By “large scale” Rempel clarified that we mean that there is a flux imbalance on large scales – comparable to the solar radius – bigger than convection). Stellar data are necessary to probe large-scale dynamo activity.
- The **effects** of large-scale dynamo action – variations in radiative and particulate output and the conversion of the Sun's flux to high energies (UV/X ray) – on decadal and longer time scales – are neither well measured nor understood.

Some conclusions were clear:

- The **ensemble** of sun-like stars indicates richer behavior that might have been anticipated. Stars appear to have multiple cycle periods (including the Sun), cycles may lose phase coherence, and can lie in different regimes (such as in the Bohm-Vitense rotation vs period plot). A couple of stars appear to change from cycling to Grand Minima. Work in this area is surely going to be profitable as our stellar database approaches almost 5 decades.
- Long timeseries of stellar and solar data in milli-magnitude photometry, and activity indices, are critical.
- There is a need to recover the entire dataset from the Mt. Wilson archive, filling gaps from ca. 1991-2003, that are only partly covered by SSS and other data. After the meeting Saar tracked down Bob Donahue.
- A new homogeneous database of solar-stellar synoptic observations is of high priority. There is a need to obtain a list of other observers and observatories who have already and will obtain such data in future. Both SSS and SMARTS seem to be good candidates from which to develop the database.
- The NSO solar ISS instrument has 10 channels of 0.5-1 nm width and a spectral resolution of around 5×10^5 . It was agreed that at least the G band data (388 nm) deserve attention for comparison with Ca II in the Sun. Some stellar CN band data have been acquired and processed by Saar.
- Some stars are “special” having been “sounded” by Kepler (C. Karoff's 20 most Sun-like stars), being especially solar-like (18 Sco), or are stars that are entering or leaving grand minima, for example. These should serve as targets for individual study.
- Kepler II will obtain important data on various Mt Wilson stars and cluster stars such as Hyades and M67 stars. About 12 Kepler II target stars coincide with the Mt. Wilson survey.
- The new Lowell DCT and LCOGT telescopes are well suited to continued solar-stellar studies should competition for time allow.

Several other important points included:

- Rempel noted the coupling between differential rotation and convection in the Sun is fundamentally not understood.
- Pevtsov requested that the group provide additional motivations for continued sun-as-a-star measurements at NSO.
- Metcalfe noted that this kind of work has almost exclusively been funded privately in the past. To whom then should a “white paper” be directed?

Possible PhD projects- Ricky Egeland's perspective

Ricky Egeland is interested to begin Ph.D. work by assembling the various disparate datasets into a coherent database of solar-stellar observations, while at the same time analyzing those data which remain unprocessed and comparing observations where targets overlap. The parameters of interest, nicely outlined in Saar's talk, are a starting point for what the database ought to contain. During the meeting we found that MWO results from 32 stars (from the Lockwood et al., 2007, ApJSS, 171, 260 paper) are in the possession of Rich Raddick. Ricky will begin the database by combining these results with the Lowell observations, contacting Rich and Jeff for the data and necessary advice. Integration of other datasets can follow sometime after that, but should include Fairborn and NSO Sun-as-a-star at least. Travis also revealed that some of the Southern HK SMARTS observations remain unprocessed and cycles unpublished, and Ricky is willing to help with that. Finally, Ricky is interested in exploring 2-cycle dynamo models, and possible transition/mode-switching mechanisms for the solar dynamo that could explain the Sun's position in the Bohm-Vitense diagram.