# The 4th SONG Workshop


## September 15 - 20, 2011

* Status of Danish and Chinese SONG instruments.
* Development of U.S. SONG instruments and establishment of partner institutions.
* Science with a three-node SONG network.
* Interactions between SONG and other instruments.
* Mini-SONG.
* Future SONG Nodes.

COLLEGE of CHARLESTON

DEPARTMENT OF PHYSICS & ASTRONOMY

Poster Design & Graphic: Fahn Hakkila

## Scientific Organizing Committee

Jon Hakkila (co-chair)
Joergen Christensen-Dalsgaard (co-chair)
Yan Li (co-chair)
James Neff
Licai Deng
Jason Jackiewicz
Uffe Graae Joergensen
Travis Metcalfe
Frank Hill
Katrien Uytterhoeven

## Local Organizing Committee

Jon Hakkila (co-chair)
James Neff (co-chair)
Alfair Meredith
Fahn Hakkila
Robert Dukes
Joseph Carson

## Acknowledgements

National Science Foundation International Research and Education Award
The College of Charleston

# Fourth SONG Workshop - Program

## Thursday, September 15

NSCB Atrium

| | | |
|---|---|---|
| 06:00 – 09:00 p.m. | Registration and Reception | |

## Friday, September 16

Stern Center Ballroom

### Introductions

| | | |
|---|---|---|
| 08:30 – 09:00 a.m. | Coffee and Registration | |
| 09:00 – 09:15 a.m. | Welcome | George Hynd, Provost<br>Mike Auerbach, SSM Dean |
| 09:15 – 09:30 a.m. | Workshop introduction and logistics | Jon Hakkila and Jim Neff |

### SONG Status Report

Chair: Jason Jackiewicz

| | | |
|---|---|---|
| 09:30 – 10:00 a.m. | SONG overview | Jørgen Christensen-Dalsgaard |
| 10:00 – 10:30 a.m. | Danish prototype update | Frank Grundahl |
| 10:30 – 11:00 a.m. | SONG node at Tenerife | Katrien Uyterrhoeven |
| 11:00 – 11:30 a.m. | Group photo and Coffee break | |
| 11:30 – 12:00 p.m. | Chinese Prototype update | Licai Deng |
| 12:00 – 12:30 p.m. | Extrasolar planets - Radial velocity method | Paul Butler |
| **12:30 – 2:00 p.m.** | **lunch break** | |

### SONG Science: Stellar Astrophysics

Chair: Jørgen Christensen-Dalsgaard

| | | |
|---|---|---|
| 2:00 – 2:30 p.m. | Chinese SONG progress | Guomin Wang |
| 2:30 – 3:00 p.m. | Stellar Oscillations | Sarbani Basu |
| 3:00 – 3:30 p.m. | Stellar Oscillations | Marc Pinsonneault |
| 3:30 – 4:00 p.m. | Coffee break | |
| 4:00 – 4:30 p.m. | Stellar Oscillations | Jesper Schou |
| 4:30 – 5:00 p.m. | Convective motion in solar-like and RGB stars | Yan Li |
| 5:00 – 5:15 p.m. | Update | LOC |

## Saturday, September 17

New Science Center Building

### Poster Session

08:00 – 09:00 a.m. poster setup in NSCB atrium; coffee and registration

### SONG Science: Extrasolar Planets

Chair: Licai Deng

| | | |
|---|---|---|
| 09:00 – 09:30 a.m. | Microlensing method | Martin Dominik |
| 09:30 – 10:00 a.m. | Light curve method | Angelle Tanner |
| 10:00 – 10:30 a.m. | Transits via color photometry | Brandon Tingley |
| 10:30 – 11:00 a.m. | Coffee break and poster viewing | |
| 11:00 – 11:30 p.m. | IAC Science with SONG OT | Katrien Uyterrhoeven |
| 11:30 – 12:00 p.m. | Extrasolar planets | Joe Carson |
| 12:00 – 1:30 p.m. | lunch break and poster viewing | |

### SONG Science: Stellar Astronomy and Additional Objectives

Chair: Yan Li

| | | |
|---|---|---|
| 1:30 – 2:00 p.m. | Solar observations | Frank Hill |
| 2:00 – 2:30 p.m. | Doppler Imaging using SONG | Shenghong Gu |
| 2:30 – 3:00 p.m. | Young active stars | Huijuan Wang |
| 3:00 – 3:30 p.m. | Coffee break and poster viewing | |
| 3:30 – 4:00 p.m. | Optical pulses in GRBs | Jon Hakkila |
| 4:00 – 4:30 p.m. | CofC's proto-mini-SONG node at UVI | Jim Neff |
| 4:30 – 4:35 p.m. | Update | LOC |

### Poster Presentations

| | |
|---|---|
| Asteroseismology at BNU | Jianning Fu |
| The Future SONG Data Archive | Rasmus Handberg |
| The SONG Spectrograph - Specs & Initial Performance | Jens Jessen-Hansen |
| Unusual Pulsation Properties of RGB Stars with KEPLER | Jean McKeever |
| Rapid Variability & Evolution of Starspots with SONG | James Neff |
| Analysis and Optimization of the SONG Telescope | Zhiyong Zhang |

## Sunday, September 18

New Science Center Building

### Poster Session

09:00 – 09:30 a.m. Coffee and poster viewing in NSCB Atrium

### Interactions between SONG and other Instruments

Chair: Frank Hill

| | | |
|---|---|---|
| 09:30 – 10:00 a.m. | SONG and LCOGT | Tim Brown |
| 10:00 – 10:30 a.m. | GCN and SONG/mini-SONG | Scott Barthelmy |
| 10:30 – 11:00 a.m. | Coffee break and poster viewing | |
| 11:00 – 11:30 a.m. | SONG networking and computational infrastructure | Søren Frandsen |
| 11:30 – 12:00 p.m. | SONG software/web interface | Mads Andersen |
| 12:00 – 12:30 a.m. | Chinese SONG/mini-SONG software | Xiaomeng Lu |
| 12:30 – 2:00 p.m. | lunch break and poster viewing | |

### The Plan for U.S. SONG Nodes

| | | |
|---|---|---|
| 02:00 – 04:00 p.m. | Panel discussion on U.S. SONG nodes | Frank Hill, Jason Jackiewicz, James Neff, Jon Hakkila. |
| 04:00 – 04:15 p.m. | Tour and banquet information | LOC |
| 04:15 – 05:20 p.m. | Coffee break and poster viewing | |
| 05:20 – 06:00 p.m. | Remove posters from NSCB Atrium | |

### Workshop Banquet

06:30 – 10:00 p.m.

## Monday, September 19

Stern 206

**08:30 – 09:30 a.m. Coffee**

### Mini-SONG

Chair: Katrien Uyterhoeven

| | | |
|---|---|---|
| 09:30 – 10:00 a.m. | mini-SONG telescopes and instruments | Xiaojun Jiang |
| 10:00 – 10:30 a.m. | Transiting exoplanets with mini-SONG | Licai Deng |
| 10:30 – 11:00 a.m. | Coffee break | |
| 11:00 – 11:30 a.m. | Open clusters / time-domain searches | Huijuan Wang |
| 11:30 – 12:00 p.m. | Asteroid families with mini-SONG | Xiao-bin Wang |
| 12:00 – 01:30 p.m. | lunch break | |

### Other SONG Nodes and the Future of the SONG Network

NSCB 129

| | | |
|---|---|---|
| 1:30 – 3:00 p.m. | Discussion of SONG and Mini-SONG | All |
| 3:00 – 3:30 p.m. | Coffee break | |
| 3:30 – 4:00 p.m. | Workshop Summary | |
| 4:00 – 4:15 p.m. | Closing Remarks | LOC |

### SONG Steering Committee Meeting

Rita Liddy Hollings Science Center room 324

7:00 – 8:30 p.m.

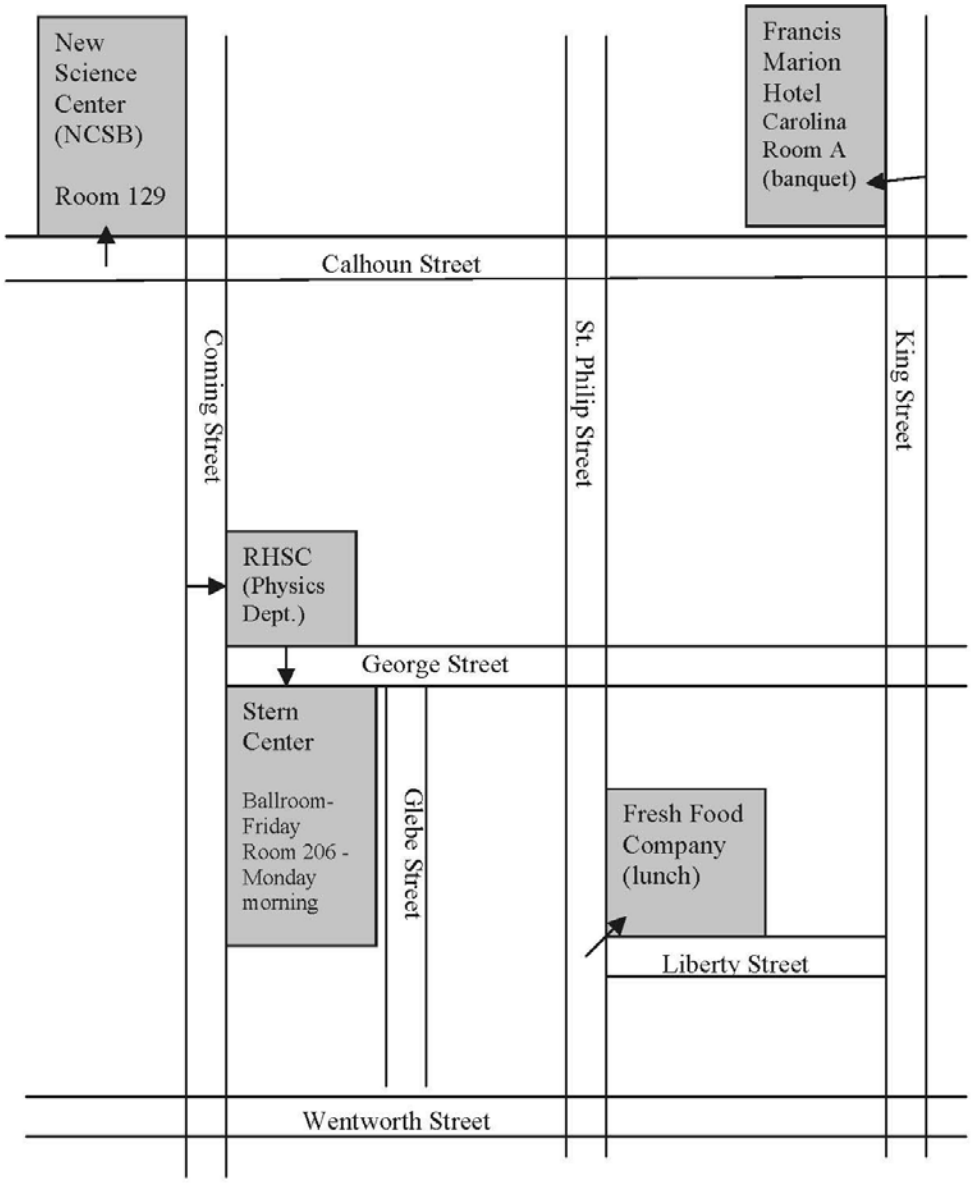
## Tuesday, September 20

### Informal Working Groups/Day Tours of Charleston

8:00 a.m. – 6:00 p.m.

# Fourth SONG Workshop - Venue

| | |
|---|---|
| Thursday night | Reception- NCSB Atrium |
| Friday | Stern Center Ballroom |
| Saturday & Sunday | NCSB 129 |
| Sunday night | Banquet - Francis Marion Hotel |
| Monday morning | Stern Center 206 |
| Monday afternoon | NCSB 129 |



Session 1. SONG Status Report
09:30-12:30 Friday, 16 September
Stern Center Ballroom

## SONG OVERVIEW

*Jørgen Christensen-Dalsgaard*
*Dept. of Physics & Astronomy, Aarhus University, Denmark*

The SONG project is approaching a very exciting stage, with the imminent deployment of the first node on Tenerife. I provide an overview of the scientific goals and organization of the project and discuss the history that has led us to the present configuration. In addition, I present some thoughts on the future developments, in the broader context of time-domain astrophysics.

## THE SONG PROTOTYPE NODE - LATEST NEWS

*Frank Grundahl*
*Dept. of Physics & Astronomy, Aarhus University, Denmark*

The status of the SONG prototype node will be described. I will present the status of the instrumentation, which is comprised of a 1m telescope equipped with a high-resolution spectrograph and two lucky-imaging cameras. The status of the work on the telescope and initial tests of the velocity precision that can be obtained with the spectrograph will be presented.

## SONG-OT: THE PROTOTYPE SONG NODE AT TENERIFE

*Katrien Uytterhoeven and Pere Pallé*
*Instituto de Astrofisica de Canarias, Tenerife, Spain*

By the end of this year the prototype SONG node, SONG-OT, will have first light. In this talk, the site of Teide Observatory will be presented, and an overview of the different stages of the construction process to date will be given.

## THE CURRENT STATUS OF SONG-CHINA

*Licai Deng*
*National Astronomical Observatory, Chinese Academy of Sciences*

China has been actively participating SONG since 2006, and signed official MoU with Aarhus University, which is the original proposer institute of SONG, in 2009, and then joint SONG officially later in that year. Together with Denmark and US, we proposed to establish the Northern SONG as a early layout of SONG, and propose to implement wide field photometry capability on the network by introduce mini-SONG (dual tube 50cm telescopes) to be attached to Northern SONG. In this talk, I will give a review on the status of SONG in China, including instrumentation and related science.

## EXOPLANETS AND HIGH CADENCE OBSERVATIONS

*Paul Butler*
*Dept. of Terrestrial Magnetism, Carnegie Institution of Washington*

High cadence observations have the potential to uncover terrestrial mass planets around the nearest stars. The crucial issues include achieving single-shot precision of 1 m/s, and averaging over seismology and granulation time scales.

Session 2. SONG Science: Stellar Astrophysics
14:00-17:15 Friday, 16 September
Stern Center Ballroom

## PROGRESS ON CHINESE SONG TELESCOPE AND INSTRUMENTS

*Guomin Wang, Bozhong Gu, Songfeng Kou, Jiang Xiang, Zhiyong Zhang, Dongsheng Niu, Shihai Yang, Linzhi Xu*
*Nanjing Institute of Astronomical Optics & Technology, Chinese Academy of Science*

China has joined the SONG project and will make two 1-meter class telescopes as the nodes of SONG global network. The construction of the telescope and its instruments started in March of 2011. The telescope design and its progress will be reported in this paper. Meanwhile the schedule of the whole telescope project will be introduced in the last part of this report.

## WHY WE NEED SONG

*Sarbani Basu*
*Yale University*

Observations of stellar oscillations in velocities allow us to observe lower frequency modes than observations in intensity. Such observations are also able to detect l=3 modes. In this talk I shall illustrate how observations in velocity will allow us to make better inferences of stellar properties.

## PRECISION STELLAR ASTROPHYSICS WITH SONG

*Marc Pinsonneault*
*Ohio State University*

I review three key areas where detailed seismic studies could provide powerful constraints on stellar population studies and stellar physics: setting the dwarf absolute abundance scale by measuring the surface convection zone depth; measuring the surface helium abundance in red giants, especially in globular clusters; and inferring the internal rotation rates of subgiants. I contend that in all cases the seismic problem is well-posed and networks such as SONG can make valuable contributions.

## CAN THE EXPERIENCE FROM HELIOSEISMOLOGY HELP US WITH SONG?

*Jesper Schou*
*Stanford University*

By now solar oscillations have been observed for about 50 years with ever increasing quality and quantity of the observations. To keep up with this and to exploit the data fully we have seen substantial improvements in the analysis techniques. In this talk I will discuss some of what we have learned about pitfalls in the analysis of helioseismic data and how some of these lessons may be applicable to asteroseismic data analysis. I will also speculate about some of the unique challenges and possibilities in asteroseismology and discuss some options for how one might optimize the use of the data.

## CONVECTION IN SOLAR-LIKE AND RGB STARS

*Yan Li*
*Yunnan Astronomical Observatory and the Chinese Academy of Sciences*

Convection is a common phenomenon in stars and can significantly affets the structure and evlution of stars. The mixing-length theory is offten adopted to treat the convection, but it is a major uncertainty on the input physics of stellar models due to its over-simplifications on the turbulent motion. Turbulent convection models (TCM), which are based on the fully hydrodynamic moment equations, are a more suitable approach to deal with convection in stars. We develop a new model of the TCM, with two equations to desribe the turbulent kinetic energy and typical frequency of turbulence. We apply it to solar-like and RGB stars to explore the turbulent convection in their extensive convective envelopes.

Session 3. SONG Science: Extrasolar Planets
09:00-12:00 Saturday, 17 September
NCSB 129

## MICROLENSING METHOD

*Martin Dominik*
*University of St. Andrews*

All techniques currently applied to detect planets beyond the Solar System need to evolve further for providing population statistics. With its unusual characteristics, gravitational microlensing is sensitive to regions of planet parameter space that other techniques are blind to. While robotic telescope networks provide great opportunities with their flexible scheduling, prompt reaction, and determinism of procedures, great care needs to be taken with the scheduling in order to ensure that statistically valid samples are obtained. In principle, microlensing observations are able to even break into the Lunar-mass regime. The challenge is in obtaining ~ 1.5% photometry on main-sequence stars in the crowded fields of the Galactic bulge. This requires angular resolutions of 0.4", achievable with lucky imaging on 1m-class telescopes. While we have carried out test observations with the Danish 1.54m at ESO La Silla (Chile) as part of the MiNDSTEp campaign, the SONG telescopes are unique in essential parts of their design being optimised for this goal.

## DETECTING AND CHARACTERIZING TRANSITING PLANETS WITH SONG

*Angelle Tanner*
*Mississippi State University*

The discovery of hot Jupiter planets opened the door for the detection of the first transiting planet, HD 209458, because we knew the odds were good that a planet orbiting so close to its star could in fact pass between us and the star. Since the discovery of the transit of HD 209458 in 1999, well over one hundred such planetary systems have been detected from both the ground and space. While some of the most recent and exiting transiting planet discoveries have and are being made by the space-based Kepler satellite, whose primary focus is the detection of habitable Earth-mass planets around Sun-like stars, there is still much transit detection work to be done from the ground with small telescopes. Indeed, many telescopes located on college campuses and in the backyards of amateur astronomers have been used to contribute to our knowledge of transiting planetary systems and the stars they inhabit. Here, I will review the history of this exoplanet discovery method and touch upon how the SONG network can contribute to this area of research including both the detection and characterization of transit light curves as well as to what degree the intrinsic variability of the host star affects our ability to detect Earth-mass planets.

## USING SONG PHOTOMETRY TO CONFIRM TRANSIT CANDIDATES THROUGH COLOR CHANGES DURING TRANSIT

*Brandon Tingley, Hannu Parviainen, Hans Deeg*
*Instituto de Astrofisica de Canarias*

If transits of planets are observed in multiple colors a color signature is revealed that is very distinct from those produced by eclipsing binaries, blended or otherwise. It arises due to the interplay between the comparatively small size of the planets relative to its parent star and differential limb darkening. While it has its limitations, this technique can provide relatively quick confirmations without heavy consumption of telescope resources for some candidates. In addition to this use, these same observations can also be used to test model stellar atmospheres, both to determine if their accuracy is sufficient for PLATO mission goals and to evaluate if the one-dimension models currently used to generate limb-darkening coefficients are sufficient to explain the observations -- otherwise the new 3-D models might need to be used. As these new models suggest a very different value for the metallicity of the Sun, this could have far-reaching, even cosmological, implications. SONG is capable of performing simultaneous multi-color photometry, making it an ideal instrument for this endeavor.

## IAC SCIENCE WITH THE PROTOTYPE SONG NODE AT TENERIFE

*Katrien Uytterhoeven, P. Palle, and the IAC*
*Instituto de Astrofisica de Canarias*

For many astrophysical problems high-precision, high-resolution spectral observations are crucial. The SONG telescope and its spectrograph are hence very useful instruments for a large range of research areas. We will present an overview of science cases, ranging from stellar studies to studies of globular clusters, proposed by different research groups at the Instituto de Astrofisica de Canarias, and that are ideal filling programs for the proto-type SONG node at Tenerife during its first operation.

## SONG EXOPLANET SEARCHES IN THE CONTEXT OF NEXT GENERATION EXOPLANET SURVEYS

*Joe Carson*
*College of Charleston*

I present a comparison of SONG exoplanet searches and the next generation of planned exoplanet surveys. This includes a discussion of upcoming exoplanet surveys from both the ground and space, covering techniques such as microlensing, direct imaging, Doppler spectroscopy, astrometry, and transits. I show comparative sensitivities as a function of exoplanet mass, temperature, and semimajor axis, as well as host star spectral type and age. I discuss the SONG survey's potential role in shaping our understanding of exoplanet origin and evolution.

Session 4. SONG Science: Stellar Astronomy and Additional Objectives
14:00-16:35 Saturday, 17 September
NCSB 129

## SOLAR OBSERVATIONS WITH SONG

*Frank Hill, National Solar Observatory*
*and Frank Grundahl, Aarhus University*

The SONG instrumentation is capable of detecting the solar oscillations by observing the daytime sky. This unusual approach has only been exploited a few times in the past, but could open up a new avenue for solar physics. In particular, the large spectral range of the SONG spectrograph should allow multi-wavelength observations of the disk-integrated Doppler shift, which would provide information on the interaction of the solar p-modes and magnetic field, as well as provide probes of the solar atmosphere at various heights. This presentation will review the earlier studies, discuss the technical challenges of the observation, present some scientific studies that could be undertaken, and provide a look at the prototype data.

## DOPPLER IMAGING STUDY OF STARSPOTS USING SONG NETWORK

*Sheng-hong Gu, Yunnan Observatory*
*Andrew Collier Cameron, University of St. Andrews*
*and James Neff, College of Charleston*

SONG network is a powerful facility for Doppler imaging of active stars. In this talk, we introduce the research background of starspots and emphasize their important roles on stellar physics. The Doppler imaging technique is also briefly described and some relative results are illustrated. Then we discuss the advantage and disadvantage of SONG spectrograph and telescope for Doppler imaging study. Finally we purpose several research topics about starspots using SONG network: the butterfly diagrams of selected targets with long rotation periods (Sigma Gem, etc.), the differential rotation measurements and the detections for meridional flow on the surface of active stars with short rotation periods (V711 Tau, LQ Hya, etc.).

## SPECTROSCOPIC AND TIME-DOMAIN PHOTOMETRIC RESEARCH OF YOUNG ACTIVE STARS

*Huijuan Wang*
*National Astronomical Observatories, Chinese Academy of Sciences*

I will introduce my spectroscopic and time-domain photometric research of young active stars.

## SONG/MINI-SONG OBSERVATIONS OF GRB PULSED EMISSION

*Jon Hakkila*
*College of Charleston*

SONG and mini-SONG will provide excellent platforms from which to study optical flares in gamma-ray bursts (GRBs). Optical flares are observed during both GRB prompt emission and afterglows, and appear to be directly related to both GRB pulses and x-ray flares. The importance of optical flares to GRB observations is discussed.

## A PROTOTYPE MINI-SONG NODE IN THE US VIRGIN ISLANDS

*James Neff, College of Charleston*
*and David Morris, University of the Virgin Islands*

The College of Charleston and the University of the Virgin Islands jointly operate a 0.5 meter robotic/remote-controlled telescope in the US Virgin Islands. The location of the Etelman Observatory (latitude 18$^{o}$ North, longitude 65$^{o}$ West) makes it an ideal component of world-wide imaging and photometric campaigns. The island location ensures stable skies most of the year (sub arc-second seeing is common), but the tropical location creates other challenges for operating a robotic observatory. With its half-meter primary, 20x20 arc-minute field of view, 0.5 arc-second pixels, and standard filters in a 12-position wheel, it closely matches the specifications of the mini-SONG instruments. The facility is mostly operational and ready to participate in collaborative science programs with members of the SONG consortium.

Session 5. Interactions between SONG and Other Instruments
09:30-12:30 Sunday, 18 September
NCSB 129

## COMPARE AND CONTRAST SONG AND LCOGT

*Timothy M. Brown*
*Las Cumbres Observatory Global Telescope*

SONG and LCOGT both aspire to be global networks of 1m telescopes dedicated to time-domain astronomy. Up to this time, however, cooperation between them has been rather small. This does not signify rampant competition, but rather occurs because the two projects have significant differences with respect to scientific goals, technical approach, and funding strategy. I will attempt to explain these differences, in the context of LCOGT's current status and plans.

## SONG, GCN, GRBs, etc: INTERACTION POSSIBILITIES

*Scott Barthelmy*
*NASA/GSFC*

I will give a brief description of GCN (distribution methods, filtering criteria, etc) plus the types of notices currently being distributed (GRBs, transients, & monitoring). Then cover how SONG telescopes could make use of these notice types to fill in some of their observing time. I will then make a pitch to get SONG telescopes to contribute those data products that are consistent with the real-time transient aspects of GCN.

## THE ROBOTIC SOFTWARE FOR THE SONG NETWORK

*Søren Frandsen*
*Dept. of Physics & Astronomy, Aarhus University*

The SONG network will be operated in a fully automatic mode, where no operator actions are needed except for maintenance purposes or in case of problems showing up. The network is driven by Observing Requests entered into a central database that is replicated out to all sites. A scheduler at each site monitors the replicated database and decide whether there are OR's to be executed at the given site. It then performs the observations according to priorities defined in the OR's. The state of each site and the data produced are moved automatically back to the central site, where access to the system and the data will be provided by an archive server to all users. This is very much like the concept of Observing Blocks used at ESO. Calibration exposures and other household jobs are done by scripts running whenever convenient and providing input to the pipelines analysing the data. The main system elements will be described and various interfaces to the system demonstrated live. The system is still much under development and more web interfaces will be available as the system develops.

## HOW TO OBSERVE WITH SONG

*Mads F. Andersen*
*Aarhus University*

This talk will be about how to observe with one or more SONG nodes. How does the robotic telescope determine if conditions are good for observing? A short description on the computer software that handles and performs observations will be given and an example of how to use the web interfaces will be presented.

## SOFTWARE SYSTEM FOR CHINESE SONG AND MINI-SONG PROJECTS

*Xiaomeng Lu*
*National Astronomical Observatories, Chinese Academy of Sciences*

I will introduce the progress in Software system for Chinese SONG and mini-SONG projects.

## Session 6. The Plan for U.S. SONG Nodes
14:00-17:15 Sunday, 18 September
NCSB 129

A proposal was submitted to the 2010 National Science Foundation Major Research Instrumentation program requesting funding for a US SONG node(s); the proposal was made on behalf of 28 astronomers representing a large fraction of the US asteroseismology community as well as supporting members from the international SONG collaboration. The review panel did not recommend funding, but indicated several ways in which the proposal could be made more competitive. This session, led by the co-investigators on this NSF proposal, will be an open discussion of issues and ideas related to securing funding for SONG nodes in Hawaii and the southwestern US.

Session 7. Mini-SONG
09:30-12:00 Monday, 19 September
Stern Center Room 206

## MINI-SONG TELESCOPES AND INSTRUMENTS

*Xiaojun Jiang*
*National Astronomical Observatories, Chinese Academy of Sciences*

I will introduce the progress in mini-SONG telescopes and instruments.

## SEARCH FOR TRANSITING PLANETS IN OPEN CLUSTERS WITH MINI-SONG

*Presented by Licai Deng on behalf of:*
*Hui Zhang & Ji-lin Zhou*
*College of Astronomy and Space Science, Nanjing University*

We present the preliminary scheme on searching transiting planets in open clusters with mini-SONG. Our primary goal is to find the hot-Jupiter or hot-Neptune in several chosen open clusters and assess the frequency of close-in planets as a function of the age, metallicity and spin rate of their hosts. In addition, we also search for the proto-stellar disk around stars of different ages and masses. By doing so, we will gain insight into how these various properties affect the formation and evolution of planet and explain the diversity of the exoplanet systems.

## STELLAR VARIABILITY MONITORING IN OPEN CLUSTERS WITH MINI-SONG

*Presented by Huijuan Wang on behalf of:*
*Xiaobin Zhang*
*National Astronomical Observatories, Chinese Academy of Sciences*

With the mini-SONG photometric network, we plan to perform a long-term, time-series photometric survey on light variabilities in a large sample of open clusters. The main goal is to compile a complete sample of variable stars including eclipsing binaries and pulsating stars in selected open clusters, and take comparison statistical investigations of each type of variables based on the known physical parameters of star clusters. In addition, a discovery of a number of transit and flare events is expected.

## THE PHYSICAL STUDY OF SOME ASTEROID FAMILIES USING MINI-SONG

*Xiao-bin Wang*
*Yunnan Observatory*

The asteroid family is a group of asteroids with similar orbital elements. It is thought to form as results of collision between asteroids, and the members of one family are thought to be fragments of past asteroid collisions. So, the physical study on the members of an asteroid family can help us to understand the collision evolution, interior structure, strength and composition of asteroids. If we monitor core members of some asteroid families by using CCD cameras of mini-SONG network during 5 years, their light curves will be obtained and then their spin parameters (sense of spin, spin rate and orientation of spin axis) and shape can be derived. Furthermore, the distribution of spin orientation of an asteroid family can be used to infer the origin and collision evolution of the asteroid family. The distribution of asteroid size can be used to estimate the age of the family. In this presentation, several points will be concerned, (1) an introduction on background of asteroid families, (2) a summary on analysis methods of spin parameters and shape, (3) our previous work and recent progress.

Session 8. Other SONG Nodes and the Future of the SONG Network
13:30-16:15 Monday, 19 September
NCSB 129

The Chinese SONG team has proposed additional science objectives that can be realized using mini-SONG instruments. But these potential benefits come with additional challenges and costs. This session's open discussion allows members of the international SONG community to discuss how mini-SONG can best be implemented within the structure of SONG.

Session 9. POSTER SESSION
Saturday, 17 September
Sunday, 18 September
NCSB Atrium

## ASTEROSEISMOLOGY AT BEIJING NORMAL UNIVERSITY

*J. N. Fu, B.W. Jiang, S.L. Bi, Q.K. Li, Y.P. Zhang, and Y. Bai*
*Department of Astronomy, Beijing Normal University*

The main scientific research work in asteroseismology made in Beijing Normal University in recent years is briefly introduced. With the research background in asteroseismology, the group is interested in exploring the possibility of using the observation data obtained with the SONG and Mini-SONG networks to make observational and theoretical asteroseismological work.

## THE FUTURE SONG DATA ARCHIVE?

*Rasmus Handberg*
*Aarhus University*

For the past few years the KASOC (Kepler Asteroseismic Science Operations Center) has developed and driven the data archive for the asteroseismology program of the NASA Kepler mission. The goal has always been that the general framework of the KASOC archive should also be used for the SONG project. In this poster I will present the current status and structure of the KASOC database and discuss the prospects for customizing the archive to the much more complex and versatile SONG project. This includes thoughts of requirements for the different SONG data products.

## SUITABILITY OF THE APACHE POINT OBSERVATORY 1M TELESCOPE FOR THE SONG SPECTROGRAPH

*Jason Jackiewicz and Jon Holtzman*
*New Mexico State*

It has been difficult to obtain funding for the 1-2 SONG nodes that are needed in the U.S. to complete a robust northern hemispheric network. One possible option is to proceed in a way so as to secure the critical components for a complete SONG node in a piece-wise fashion, likely using existing facilities as a temporary solution. We discuss the potential benefits and drawbacks of adapting the most important SONG component, the spectrograph, to an existing 1m telescope at Sacramento Peak, NM.

## THE SONG SPECTROGRAPH - CHARACTERISTICS, CAPABILITIES, AND INITIAL TESTS OF PERFORMANCE

*J. Jessen-Hansen, F. Grundahl, S. Frandsen, M. F. Andersen, et al.*
*Aarhus University*

The Stellar Observations Network Group (SONG) project aims at producing high quality radial velocity measurements of bright stars with a network of 1m class telescopes. Each node will have an identical high resolution Échelle spectrograph mounted at a Coudé focus housed in a separate container next to the dome. The assembly and alignment of the prototype spectrograph is well under way at the Department of Physics and Astronomy, Aarhus University. On this poster we present the characteristics and the expected capabilities of the SONG spectrograph together with initial test measurements of the solar radial velocity conducted both with iodine cell and 'standard' ThAr wavelength calibration.

## UNUSUAL PULSATION PROPERTIES OF RGB STARS OBSERVED BY KEPLER

*Jean McKeever, Jason Jackiewicz, Bernie McNamara*
*New Mexico State University*

We present our preliminary findings on analysis of Kepler lightcurves for 55 stars near the top of the red giant branch (RGB). Most stars show single strong peaks at low frequencies in their power spectra (slowly pulsating with periods on the order of days to weeks). Other stars show more complex pulsations with multiple periods and a few are likely to be in binary systems. An analysis of the population as a whole will be presented.

## USING SONG TO PROBE RAPID VARIABILITY AND EVOLUTION OF STARSPOTS

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The Stellar Observations Network Group (SONG) is being developed as a network of 1-meter spectroscopic telescopes designed for and primarily dedicated to asteroseismology. It is patterned after the highly successful GONG project. The Danish prototype telescope will be installed in Tenerife in early 2011. Ultimately we hope to have as many as 8 identical nodes pro- viding continuous high-resolution spectroscopic observations for targets anywhere in the sky. The primary scientific goals of SONG are asteroseismology and the search for Earth-mass exoplanets. The spectroscopic requirements for these programs push the limits of current technology, but the resulting spectrograph design will enable many secondary science programs with less stringent requirements. Doppler imaging of starspots can be accomplished using continuous observations over several stellar rotations using identical instrumentation at each node. It should be possible to observe the evolution of starspot morphology in real-time, for example. We discuss the design and status of the SONG project in general, and we describe how SONG could be used to probe short timescale changes in stellar surface structure.

## ANALYSIS AND OPTIMIZATION OF THE SONG TELESCOPE

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SONG is an international initiative to design, build, and utilize a global network of eight 1-meter class telescopes to be operated as a whole-Earth telescope. For an astronomical telescope mount, having a high stiffness to support the mirror cell and instruments is its basic function. Finite element method (FEM) is a powerful tool to help structure design engineer to achieve this goal. In this paper, with the help of ANSYS, the static and modal analysis, calculation and optimization of the SONG telescope mount will be given. The FEM results show that the structure, designed for SONG telescope, is feasible and reliable and have a high stiffness-to-weight ratio to meet the optical demands.