

## OBSERVING TIME PROPOSAL FORM FOR NEW SOLAR TELESCOPE (NST)

### Important Notes:

#### Two Proposal Submission Deadlines:

- **15 April 2015 for Session 1 (May 1 - June 30)**
- **1 June 2015 for Session 2 (July 1 - 31 and September 15 - October 31)**

1. Time window available for 2015: May 1 - July 31 and September 15 - October 31;
2. For the information of NST and BBSO, please visit <http://www.bbso.njit.edu>;
3. For the instrument information, feel free to contact Prof. Wenda Cao at [wcao@bbso.njit.edu](mailto:wcao@bbso.njit.edu);
4. Final decision on telescope allocation for session 1 and session 2 will be made no later than April 25 and June 15 2015, respectively by BBSO Telescope Allocation Committee (TAC). High priority may be given to the PIs who produced good scientific results from the previous observations, to the proposals with scientifically challenging and achievable objectives, and the observing proposal with coordinated observations.

**Make sure to submit your proposal in PDF format to Wenda Cao (TAC chair) via [wcao@bbso.njit.edu](mailto:wcao@bbso.njit.edu) before the deadlines**

Qualified internal and external applicants:

1. Internal applicants refer to the scientific staff residing at BBSO, scientists and students in NJIT's Center for Solar-Terrestrial Research, and BBSO partners.
2. External applicants refer to the scientists and students from the institutes or universities in USA recognized by NSF or NASA.
3. The PI must have a PhD degree or be a PhD student with the supervisor as the Co-I.

### Acknowledgement Requirement:

Please acknowledge BBSO and the instrument PIs in the paper relevant to this observation:  
*BBSO operation is supported by NJIT, US NSF AGS-1250818 and NASA NNX13AG14G*

# 1 General Information

## 1.1 Applicant Name and Affiliation

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**PI:** V. Yurchyshyn   New Jersey Institute of Technology

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\*Note that Co-Is have the same data access rights as the PI. Please coordinate data access among team members.

## 1.2 Proposal Information

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- ☐ Renewal or continuation
- ☒ Linked to an US NSF funding
- ☒ Linked to an AFOSR funding
- ☐ Linked to a PhD thesis in preparation and led by a PhD student
- ☐ A coordinated observation with a ground-based telescope
- ☒ A coordinated observation with a space-based observatory (e.g. IRIS or Hinode)

## 1.3 Observing Conditions

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- ☒ Good Seeing
- ☒ Sky Clarity
- ☒ Low Water Vapor
- ☒ Specific Solar Activity
- ☐ Quiet Sun Observation
- ☐ Solar Limb Tracking

## 1.4 Preferred Observing Date and Time\*

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- ☐ Fixed Date: 13 - 19 June 2015
  - ☒ Flexible Date: 5 - 7 days
    - 2 runs per Session if possible
  - ☐ Fixed Observing Time: 18:20:45 UT - 19:00:05 UT
  - ☒ Suggested Observing Time: 16:30:00 UT - 22:30:00 UT
  - ☐ Observing Conditions Permitting
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\*Note that Fridays may be occupied for telescope engineering time.

## 2 Scientific Rationale

### 2.1 Title

#### Magnetic Field Dynamics in Sunspot Light Bridges

### 2.2 Abstract

We propose to observe the fine structure of the chromosphere and the transition region above the sunspot umbra. The objective is to explore the dynamics of light bridges observed in the umbra of sunspots and the associated chromospheric, transition region and coronal activity. This research plan is motivated by high resolution observations of sunspots using the New Solar Telescope.

### 2.3 Short Summary of the Request

We propose to observe the fine structure of the chromosphere and the transition region above the sunspot umbra. The growing number of publications unequivocally show that the sunspots umbra is not a quiet and dull place as was previously thought. Fine scale chromospheric umbral jets, dynamic fibrils, oscillations as well structured up-flows seen in the chromosphere and transition region all suggest that there is hidden, unexplored and not understood dynamics, the role of which in many important questions of solar physics is largely unknown (e.g., energy and mass supply for coronal heating, formation and evolution of sunspots, connection between photospheric oscillations and solar atmosphere).

The objective is to explore the dynamics of light bridges observed in the umbra of sunspots and the associated chromospheric, transition region and coronal activity. This research plan is motivated by high resolution observations of sunspots using the New Solar Telescope.

### 2.4 Scientific Rationale

We put forward an hypothesis that LBs may play an essential role in heating the coronal loops rooted in the umbra (hereafter umbral loops). There is no a well accepted theory of heating of the umbral loops. We do not know with certainty why they appear filamented and why they are non-uniformly rooted over the umbra. We suggest that the underlying photospheric dynamics is responsible for that structuring. In particular LBs, which are the most dynamic umbral features may fuel the heating process. We propose to test this suggestion.

### 2.5 Results from Previous NST Observations

Cho, K.-S., Bong, S.-C., Nakariakov, V. M., et al. 2015, ApJ, 802, 45

Yurchyshyn, V., Abramenko, V., & Kilcik, A. 2015, ApJ, 798, 136

- Bong, S.-C., Cho, K.-S., & Yurchyshyn, V. 2014, *Journal of Korean Astronomical Society*, 47, 311
- Vargas Domínguez, S., Kosovichev, A., & Yurchyshyn, V. 2014, *ApJ*, 794, 140
- Yurchyshyn, V., Abramenko, V., Kosovichev, A., & Goode, P. 2014, *ApJ*, 787, 58
- Abramenko, V. I., Zank, G. P., Dosch, A., et al. 2013, *ApJ*, 773, 167
- Lim, E.-K., Yurchyshyn, V., Goode, P., & Cho, K.-S. 2013, *ApJ Lett*, 769, LL18
- Yurchyshyn, V., Abramenko, V., & Goode, P. 2013, *ApJ*, 767, 17
- Abramenko, V. I., Yurchyshyn, V. B., Goode, P. R., Kitiashvili, I. N., & Kosovichev, A. G. 2012, *ApJ Lett*, 756, LL27
- Yurchyshyn, V., Abramenko, V., & Watanabe, H. 2012, *Hinode-3: The 3rd Hinode Science Meeting*, 454, 311
- Goode, P. R., Abramenko, V., & Yurchyshyn, V. 2012, *Physica Scripta*, 86, 018402
- Yurchyshyn, V., Ahn, K., Abramenko, V., Goode, P., & Cao, W. 2012, *arXiv:1207.6418*
- Yurchyshyn, V., Kilcik, A., & Abramenko, V. 2012, *arXiv:1207.6417*
- Lim, E.-K., Yurchyshyn, V., & Goode, P. 2012, *ApJ*, 753, 89
- Kitiashvili, I. N., Abramenko, V. I., Goode, P. R., et al. 2012, *arXiv:1206.5300*
- Abramenko, V., Yurchyshyn, V., & Goode, P. R. 2012, *4th Hinode Science Meeting: Unsolved Problems and Recent Insights*, 455, 17
- Kilcik, A., Yurchyshyn, V. B., Rempel, M., et al. 2012, *ApJ*, 745, 163
- Abramenko, V. I., Yurchyshyn, V. B., & Goode, P. R. 2011, *arXiv:1112.2750*
- Abramenko, V. I., Carbone, V., Yurchyshyn, V., et al. 2011, *ApJ*, 743, 133
- Lim, E.-K., Yurchyshyn, V., Abramenko, V., et al. 2011, *ApJ*, 740, 82
- Yurchyshyn, V. B., Goode, P. R., Abramenko, V. I., & Steiner, O. 2011, *ApJ Lett*, 736, LL35
- Abramenko, V., Yurchyshyn, V., Goode, P., & Kilcik, A. 2010, *ApJ Lett*, 725, L101

## 2.6 List of Relevant Publications

- Lagg, A., Solanki, S. K., van Noort, M., & Danilovic, S. 2014, *A&A*, 568, A60
- Louis, R. E., Beck, C., & Ichimoto, K. 2014, *ArXiv e-prints*
- Yurchyshyn, V., Abramenko, V., Kosovichev, S., and Goode, P. *Astrophys. J.*, 787/1, 58
- Yurchyshyn, V., Abramenko, V., & Kilcik, A. 2015, *ApJ*, 798, 136

## 2.7 Expected Results

WE expect to obtain parameters of plasma flows and magnetic fields in LBs and connect them to the associated chromospheric and TR activity.

### 3 Observing Programme

1) TiO: 15 sec cadence 2) VIS: a) 5 point scan (+/- 0.8, 0.4, 0.0) and cadence of 15 sec b) during activity periods switch to 11-point scan with minimal delay time 3) NIRIS: standard polarimetry observations

#### 3.1 Instrumentation Requirements\*

- ☒ Adaptive Optics (AO-308)
- ☒ Broad-band Filter Imager (BFI)
- ☐ Fast Imaging Solar Spectrograph (FISS)
- ☒ Visible Imaging Spectrometer (VIS)
- ☒ Infrared Imaging Spectro-polarimeter (NIRIS)
- ☐ Cryogenic Infrared Spectrograph (CYRA)
- ☐ Other

\*Note that FISS and VIS can't be used simultaneously. CYRA can't operate with all other instruments simultaneously.

#### 3.2 Observational Strategy

This observing run will be joint with IRIS instrument. TiO and VIS speckle reconstruction is required.

#### 3.3 Target and Conditions

A disk sunspot with a light bridge or umbral irregularities. It may be possible that the observing run will be targeting two (or more sunspots) in one day.