# Hale Collaborative Graduate Education Program

*June 4–5, 2015 Workshop Summary* . . . . . *Steven Cranmer*

The National Solar Observatory (NSO) and the University of Colorado (CU) Boulder held a 1.5-day workshop in June 2015 to discuss the next steps for the graduate education component of our growing collaboration. This document summarizes the major topics and themes discussed at the meeting and presents some *action items* for future work (see page 6).

**Workshop web page:** http://lasp.colorado.edu/∼cranmer/CGEP_2015/

**Participants (alphabetical):**

Agrawal, Piyush (CU)
Brown, Ben (CU)
Centeno Elliott, Rebecca (HAO)
Cossette, Jean-Francois (CU)
Cranmer, Steven (CU)
Gerrard, Andrew (NJIT)
Jackiewicz, Jason (NMSU)
Kuskin, William (CU, BBA)
Longcope, Dana (MSU)
McAndrew, Quentin (CU, BBA)
Miesch, Mark (HAO)
Peck, Courtney (CU)
Pillet, Valentin Martinez (NSO)
Reardon, Kevin (NSO)
Schiff, Adam (CU)
Sturner, Andrew (CU)
Toomre, Juri (CU)
Uitenbroek, Han (NSO)

**Top-level Organization:**

The participants agreed that the original acronym CGEP (Collaborative Graduate Education Program) was a bit unwieldy, so brainstorming for a new one began. Mark Miesch proposed a new acronym that, fortuitously, does not change the actual name of the program. The participants agreed to adopt it, so henceforth we will refer to the program as the **Hale COLLAGE (COLLAborative Graduate Education) Program.** It's nice that the word "collage" points to our goal of building a common path forward in graduate education out of the existing mosaic or patchwork of individual institutions. As of June 2015, the Hale COLLAGE consortium consists officially of five universities (CU, NJIT, U. Hawaii, NMSU, MSU) and two national labs (NSO, HAO). We plan for it to grow.

**Motivation:**

Steve Cranmer presented a brief presentation of the history, motivation, and timeline of the program. At the time of the Boulder NSO bid, it was realized there is a mismatch between the need for advanced, graduate-level training in solar and space physics (to build up the next generation of DKIST observers, for example) and the ability to meet that need at any single institution. Essential expertise is distributed across universities, at research labs, and within industry. Thus, the Hale COLLAGE Program was developed to: (1) create advanced solar courses that often would attract small numbers of students at any one institution, but are needed for capacity building, (2) teach the courses using web-enabled technologies to multiple institutions, and (3) employ the highest quality interactive learning methodologies.

**Lessons Learned:**

The chief instructors from 2013 and 2014 presented summaries of their courses. Juri Toomre discussed the 2013 course "Solar and Stellar Magnetism." Some topics of discussion included:

- When lectures are distributed live ('synchronously'), it is very important to have local *facilitators* present at each of the distributed locations. During the lectures, facilitators help guide the discussion and prompt students to ask questions. More importantly, after the lectures, facilitators should revisit any topics the students may have had difficulty with and address additional questions that crop up.
- The instructors had difficulty judging how well the material was being received and digested at the remote locations.
- Having 7 instructors in a semester was probably too rapid a 'turnover,' since each of them needed some time to get comfortable with lecturing over WebEx. The rapid-fire changes in topic may also have hindered students' long-term retention of the material.
- Problem sets would have been helpful, but with so many lecturers (i.e., so many new topics being introduced), it would have been difficult to schedule them.

This discussion generated one of the main recurring questions of the workshop: **breadth vs. depth.** Do we want big-picture overviews of many topics (to make sure that students get a well-rounded introduction to as much solar physics as possible), or do we want in-depth explorations of fewer topics that dig into current research issues? We'll come back to this below.

Next, Andrew Gerrard discussed the 2014 course "Magnetospheric and Ionospheric Response to Solar Output." Slides from Gerrard (who participated via WebEx) are on the workshop web page. Topics of discussion included:

- It's important to show students how different fields (e.g., solar physics and terrestrial-based space physics) can be linked together by common physics.
- The problems that were easy for the solar students tended to be difficult for the terrestrial students, and vice versa.
- If there's just one instructor, the course development is *lots* of work. However, the students seemed to prefer the resulting coherence when just one captain is at the helm.
- It works best when each university offers it as "its own" course, each with its own instructor of record. No worries about cross-matriculation or tuition money changing hands between universities.
- Should the local facilitators (who know the local students best) get a say in their grades? Or should grading be centralized with the main instructor?

Lastly, it was noted that Sasha Kosovichev taught some kind of distributed/online solar physics course in Spring 2014. Some workshop participants thought it was a part of CGEP, and others didn't know it existed.

**Graduate Program Curricula:**

Next, the various university participants each gave a brief summary of their "core" course curriculum, as well as thoughts about how they hoped the COLLAGE program would supplement it. This round-robin type discussion was deemed necessary in order to make sure we all understood the scope of the "prerequisite problem." We need to design the COLLAGE courses to account for differing levels of preparedness.

- **CU Boulder:** Astrophysical & Planetary Sciences Department. Students get core courses in Atomic & Molecular Processes, Radiative & Dynamical Processes (some MHD), Introduction to Fluid Dynamics, Mathematical Methods, and Observations, Data Analysis, & Statistics. No entrenched solar courses, but a solar/space physics "specialty core" is being developed.

- **NJIT:** Physics Department. Core courses are standard (E&M, Classical Mech, Quantum, Stat Mech, Arfken). Fluids & plasmas are Year-2 electives, and there are occasional solar courses. Expectation: COLLAGE students are Years 3,4,5.

- **MSU:** Physics Department, but roughly 20% of the students are solar. Most core courses are physics, but Dana Longcope does an astrophysics hydro/MHD course. No dedicated stellar interiors or radiative transfer courses. Solar physics journal club (1 credit, every semester) has evolved into essential professional training.

- **NMSU:** Astronomy Department. Stars & radiative transfer are in the core curriculum. Jason Jackiewicz developed an interior/seismology special-topics course. At NMSU, previous CGEP courses were offered for 1 credit for attending & engaging with the online lectures.

We all got a better idea of the divergent aims & requirements of the various programs. This fed into to discussing future plans:

**Next Steps (meta):**

Prior to discussing the specific topics for the next (Spring 2016?) offering of the course, we realized that different stakeholders may have different ideas about the **purpose and motivation** for the COLLAGE program as a whole. These differences tended to guide whether the program was thought of as mainly for new (Years 1,2) grad students or for students already engaged with their PhD research. How do we balance the following aspects?

- Training up students for cutting-edge solar physics research.

- Providing introductory exposure to solar physics (i.e., giving them the broad foundation that "all" solar physicists should get).

- Beefing up the physics background of solar physicists.

- Recruiting more physics/astronomy students into solar physics.

- Fostering more feedback between universities and research labs (in both directions: e.g., bringing lab staff into education, and sending students to the labs for valuable experience).

- Training for societal/policy relevance (space weather).

Note that the phrase "solar" above should probably be replaced by slightly more general terms (solar/space, heliophysics, etc.) to account for our intended inclusion of the heliosphere and other universal processes common to many astrophysical environments.

In the end, we did not end up favoring any specific subset of the above goals over any other. It seems possible to unite many of them as a single goal to *develop core competencies in solar physics.* A likely outcome is that, in the near-term, each new COLLAGE course will strike its own balance on the breadth-vs.-depth issue, and we'll keep making adjustments as we develop more material.

For the future organization of COLLAGE courses, the workshop participants seemed to agree on two "rule of threes:"

1. In the near-term, we should aim for the development of 3 full courses. These would then repeat on a 3-year cycle (one per year), so that any individual grad student would have access to any/all of them within their careers.

2. The optimum number of instructors per course may also be 3; i.e., for a 3-credit course, this means that each one uses material that is appropriate for a 1-credit seminar course (e.g., 15 class hours or equivalent per semester).

**Next Steps (2016 topic):**

To help build support and community for DKIST, at CU and NSO we have been thinking of making the next course more observationally focused than the previous ones.

Draft idea: **"Topics in Solar Observation Techniques"**

1. Solar Spectropolarimetry & Instrumentation
    - 1.1. Polarized radiative transfer
    - 1.2. Polarimetric measurement & uncertainties
    - 1.3. Spectroscopy: imaging & grating-based instruments
    - 1.4. How modern spectropolarimeters work
2. Spectropolarimetric Diagnostic Techniques
    - [How we extract physical properties of solar plasma out of the data]
3. Off-limb Coronagraphy & Spectroscopy
    - 3.1. Occultation, diffraction, & instrumental scattering
    - 3.2. Visible continuum formation & off-limb diagnostics
    - 3.3. Emission line formation & off-limb diagnostics

Valentin Pillet and Steve Cranmer have offered to teach parts 1 and 3, respectively. For part 2, the following names were floated: Rebecca Centeno Elliott, Phil Judge, Han Uitenbroek, and Andy Gerrard. We also discussed the possibility that some part of this course could involve a trip to a ground-based solar observatory (Sac Peak? BBSO?) for an on-site observing project.

**Lunchtime Talk: Possibilities Within Digital Education**

William Kuskin (CU English Professor & head of the *Be Boulder Anywhere* program) gave an inspiring talk about where we may be heading with online/distance education. His Coursera MOOC (massive open online course) on comic books was used as an example of how the online experience, while alienating in some ways, can create intimacy and personal relationships in ways that the standard in-person course could never do. MOOCs (and all courses!) work best when the interaction

is not just lecturing and assessment. Generally speaking, good courses should incorporate ways for people to consider their state of being, reflect on it, engage with new experiences, and actively build new knowledge and experiences. These interactions can also be multi-layered and 'recursive,' not just a linear track from start to finish.

Digital education allows us to *split up* various pieces of a course:

1. Content delivery: making the "canon" of knowledge available
2. Guided instruction (instructor contact for questions, discussions, problem solving)
3. Guided or independent peer-to-peer exploration
4. Assessment

Not all of the above parts depend on the on-campus experience!

We discussed how MOOC-type content delivery could enable the so-called **flipped classroom** model.[1] In that model, lecture material is pre-recorded and watched by the students prior to class. The in-class contact time is then used for clarification of the material, informal discussions, answering questions, and group problem-solving. We may not be able to pre-record lectures for a full course to be offered as soon as Spring 2016, but there is interest in making the effort for at least some of it.

**Summer School at Sunspot?**

We discussed the possibility for COLLAGE program summer events, which may help the students at different universities keep in contact with one another as a cohesive group. Jason Jackiewicz discussed NMSU's ongoing process of seeking a consortium of partners to keep Sac Peak (Dunn Solar Telescope at Sunspot, NM) going as an active site for science. There are no firm monetary commitments in place yet, but the NSF has pledged some degree of matching support to keep things going. The COLLAGE summer program could involve either individual or group observing projects, and a telescope site provides an 'isolated' (immersive, team-building!) experience.

**Diversity of Lecture Video Formats**

On Friday morning, Quentin McAndrew from *Be Boulder Anywhere* showed us some additional examples of MOOC and other lecture-capture video content. Many online courses split up the screen with Powerpoint-like graphics on the left and video of a talking-head lecturer on the right. There is often some kind of motion on the Powerpoint side (animations or annotation/underlining) performed in real time by the lecturer. The more sophisticated videos cycle between animation-heavy graphics, lecturers in front of a green screen (with animations behind them), and film of the lecturer "on-location" somewhere other than the office or lecture hall. We want to strive for some degree of intimacy, so going too far in the slick/polished direction is probably unwise.

[1] The term "flipped" has come to have negative connotations in some circles, so it will be useful to come up with better and more specific terminology for what we end up doing.

## ACTION ITEMS

The participants all seemed to agree that the workshop achieved its goal of planning for the future and increasing group cohesion. Still, there is much work to be done...

☐ We need to finalize the instructors and topics for the Spring 2016 course. In the early fall (September or October 2015) we will circulate a detailed syllabus with a detailed list of topics, calendar logistics, and notes as to what activities will determine student grades.

☐ Via email or telecon, we should continue the top-level discussion of the overall purpose of the COLLAGE program and the desired balance between introductory breadth and research-level depth. We should also firm up the topics for the 3-year cycle of courses. The initial idea seems to be evolving toward:

1. The 2016 course on observations & instrumentation
2. Magnetic stars: dynamics of magnetic fields at and below the surfaces of low-mass stars across the H-R Diagram
3. Coronal & heliospheric plasma physics, with focus on universal plasma processes in flares, CMEs, and the solar wind

☐ We would like to expand the consortium and identify other universities that may like to join. Examples discussed: UNH, Rice, Catholic U., George Mason, Minnesota, Michigan, Berkeley, Stanford, UAH, BU, U. Chicago, Wisconsin.

☐ Can some of the other CU-Boulder core courses be distributed online via the Hale COLLAGE program? This might be helpful in bridging the prerequisite gap between universities. There was interest in both the *Observations, Data Analysis, and Statistics* course (which contains basics of optics & instrumentation) and *Radiative and Dynamical Processes* (which does basic radiative transfer and some MHD). Steve Cranmer will look into recording his lectures for ASTR-5700 *Stellar Astrophysics* (Spring 2016, concurrent with the next COLLAGE course).

☐ We should continue discussing plans for NSF or NASA proposals for equipment, summer salaries for course development, and/or support for student summer-school activities at observatory training sites. A seed-grant of 3–4 year duration usually requires some kind of assurance that the program will become more self-sustaining after the initial funding period. *"If you build it, they will come."* A proposal like this also needs to explain why we need to team up as a consortium in order to accomplish our goals.