

Science for All: The benefits and continued need for crowd sourced science

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Key Points:

- 1. Heliophysics as a transdisciplinary field requires solutions that address the cultural as well as the technical challenges (see white paper by McGranaghan, Thompson, Halford)**
- 2. The Zooniverse model of an open platform, available to researchers for free, has been instrumental in enabling projects ranging from TESS to LSST, and ZTF to LIGO to apply a crowd sourced science approach to data analysis.**
- 3. Crowd sourced science is a proven approach, is inherently diverse, inclusive, and provides a powerful path to moving beyond traditional connections enabling new scientific outcomes and science literacy.**

1 The role of crowd sourced science in Heliophysics and science engagement

At times throughout history, science and scientists have been thought of as elite and separate from the general population. Historically, science was done by independently wealthy individuals. Today poverty and social background are and continue to be at times insurmountable barriers for a scientific career [1]. Citizen science is one pathway to engage a larger portion of the population.

Citizen science, or the more inclusive term crowdsourced science, has been a part of Heliophysics for centuries. However, few are aware of its impact. There are clear examples throughout Heliophysics of how crowdsourced science enables scientific progress, engages the public, and encourages underrepresented groups to pursue a career in science [2, 3, 4, 5]. One of the first examples comes from solar physics in the 1700s. Edmund Halley invited the general public to help collect data for the 1715 total solar eclipse [6]. More recently, programs like SETI have captured the imagination of generations, even making appearances in popular culture [7, 8]. Today there is a multitude of crowdsourced science projects which are currently enabling science and advancing discoveries [3, 9, 10, 11, 12, 13]. By further encouraging the participation of a broader community, these projects can create a change in attitude towards science and specifically towards the field in which they participate [14, 15, 16].

Currently, there are several crowdsourced projects within Heliophysics [3, 17, 10, 18, 19], ranging from the more pure side of research with Radio Jove [20] to the applied science of space weather with SARA [10]. The projects also span the entire heliosphere. HamSCI looks at the ionosphere [18, 19], MUSICS examines waves in the magnetosphere [21], and the Sungrazer Project is helping to discover comets[17]. Citizen science has already made discoveries yet to be explained by the research community. For example, aurora enthusiasts working with Aurorasaurus researchers discovered a new type of aurora called STEVE [9].

The number of research teams wanting to build crowdsourcing projects has grown as there have been more examples of successes, and as rates and volumes of data steadily climb. For these teams to be successful, there needs to be financial and infrastructural support for crowdsourced projects. NASA recently advanced SPD-33 encouraging citizen science throughout the Science Mission Directorate.

2 Recommendations

To maximise the return of crowd sourced projects, we recommend the following:

- 1. Support and encourage the use of shared infrastructure for online citizen science;**
- 2. There should be a default move to make tools and, where plausible, data developed by missions and large projects available to all;**
- 3. Support for ongoing maintenance of citizen science platforms as infrastructure;**
- 4. Continued incorporation of explicit language in funding solicitations that encourages the use of citizen science.**

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