



# SunPy: Status of the Project and v2.0 Core Package

Monica Bobra on behalf of The SunPy Community

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**Why do we need SunPy?**

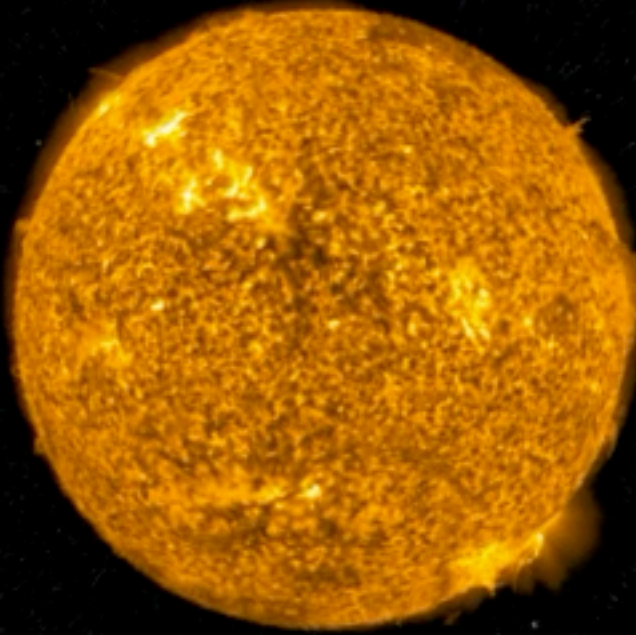
**What's in SunPy v2.0?**

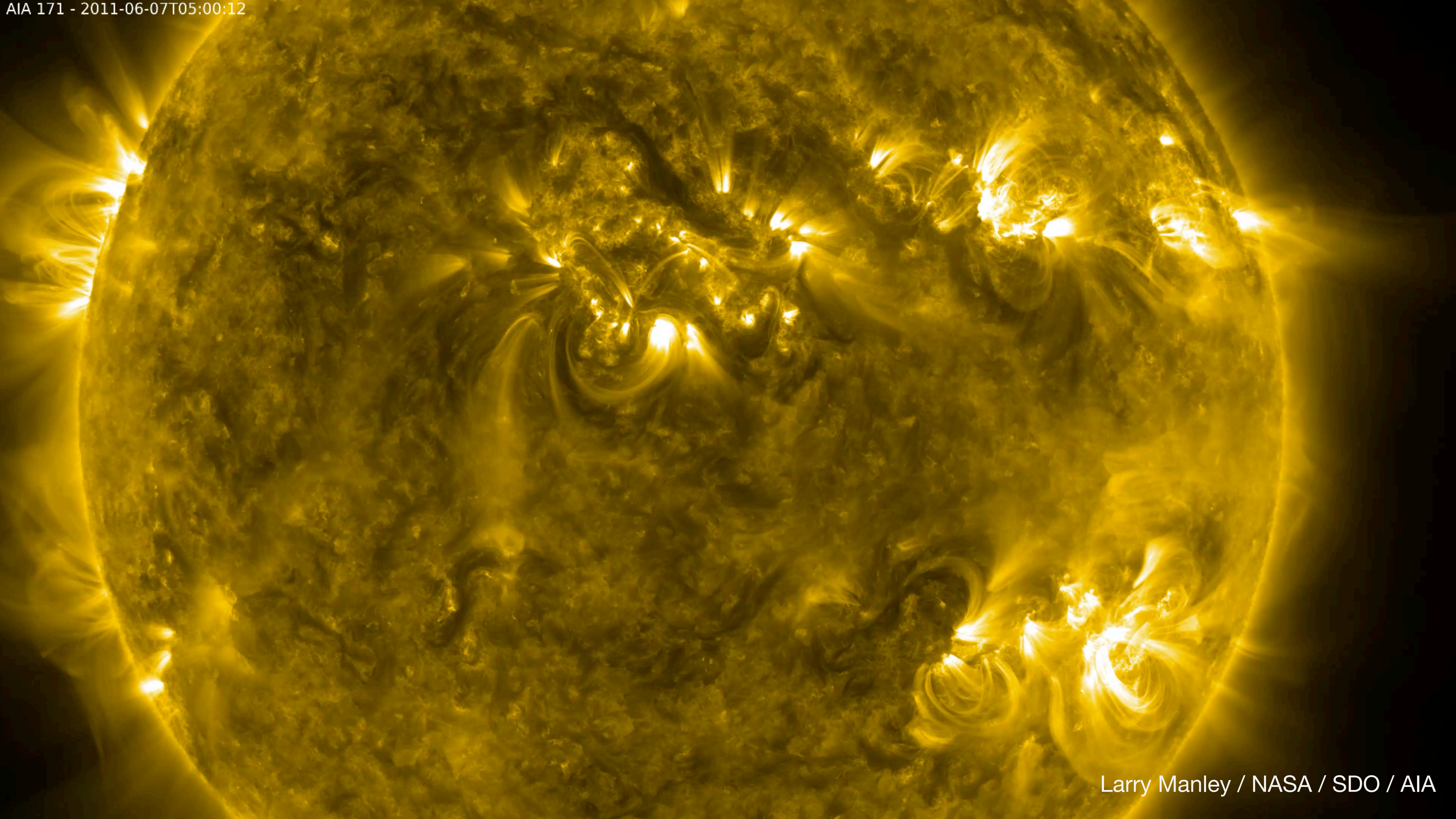
**How did we (hopefully) gain visibility?**

**Why do we need SunPy?**

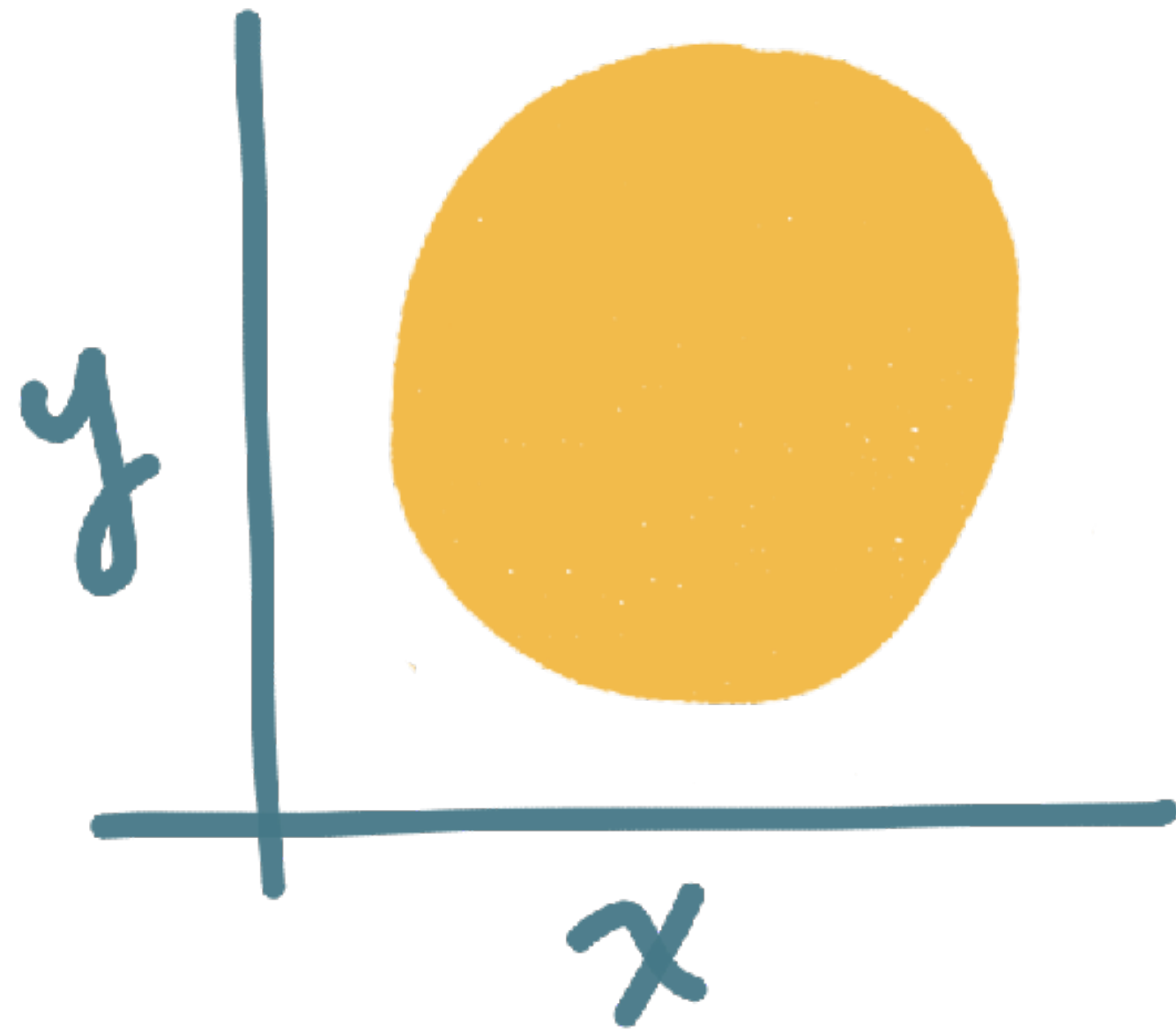
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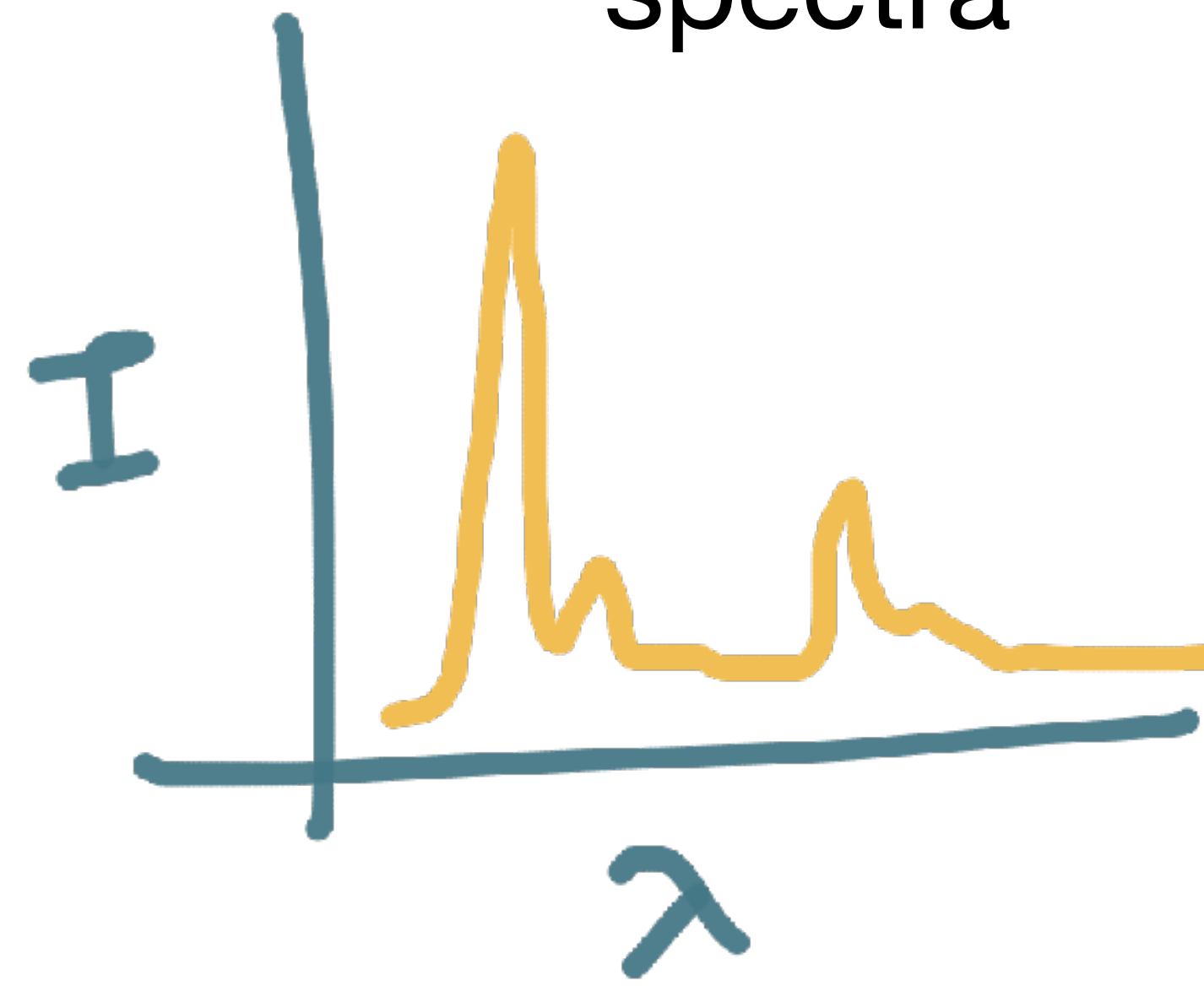




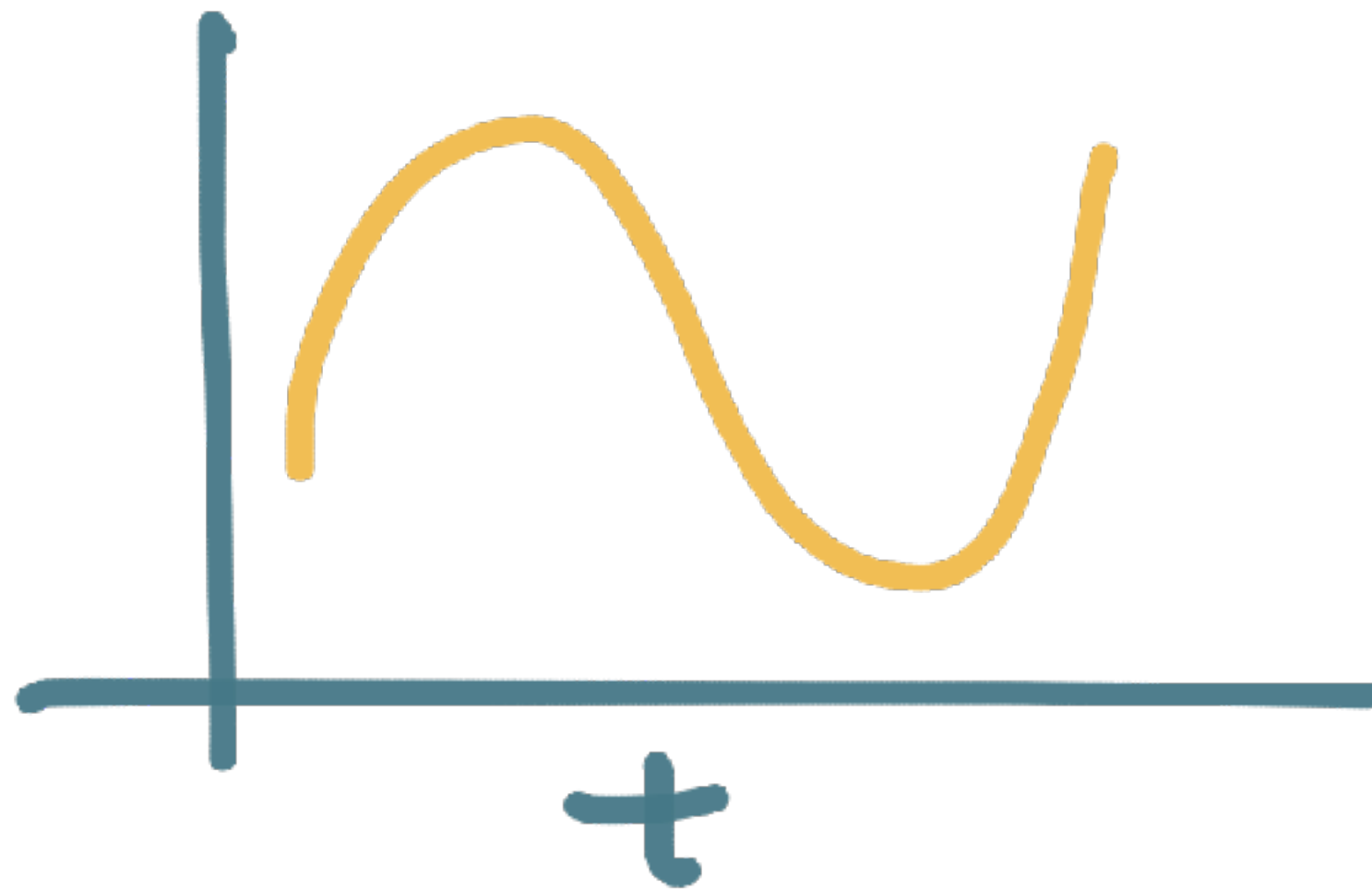
image



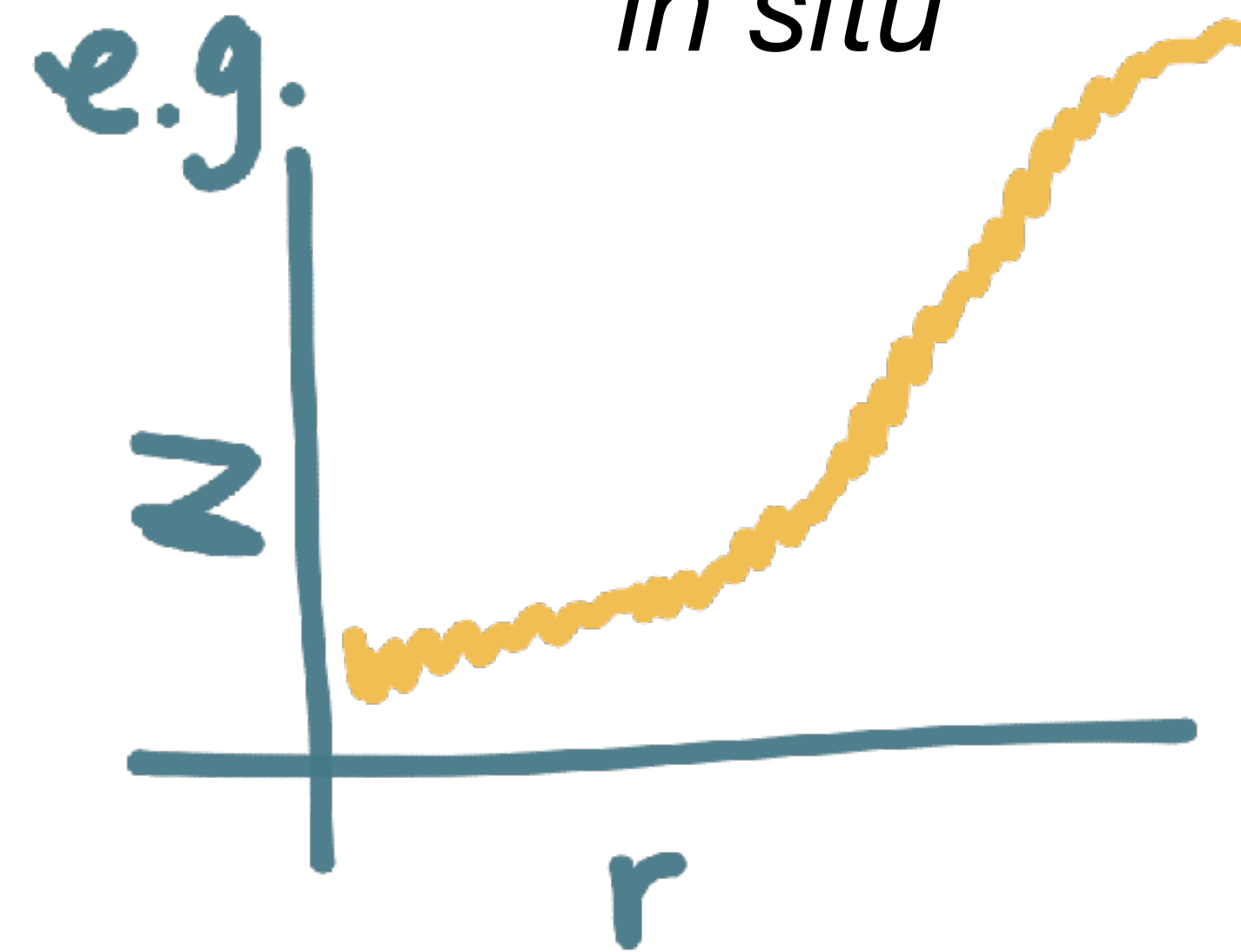
spectra

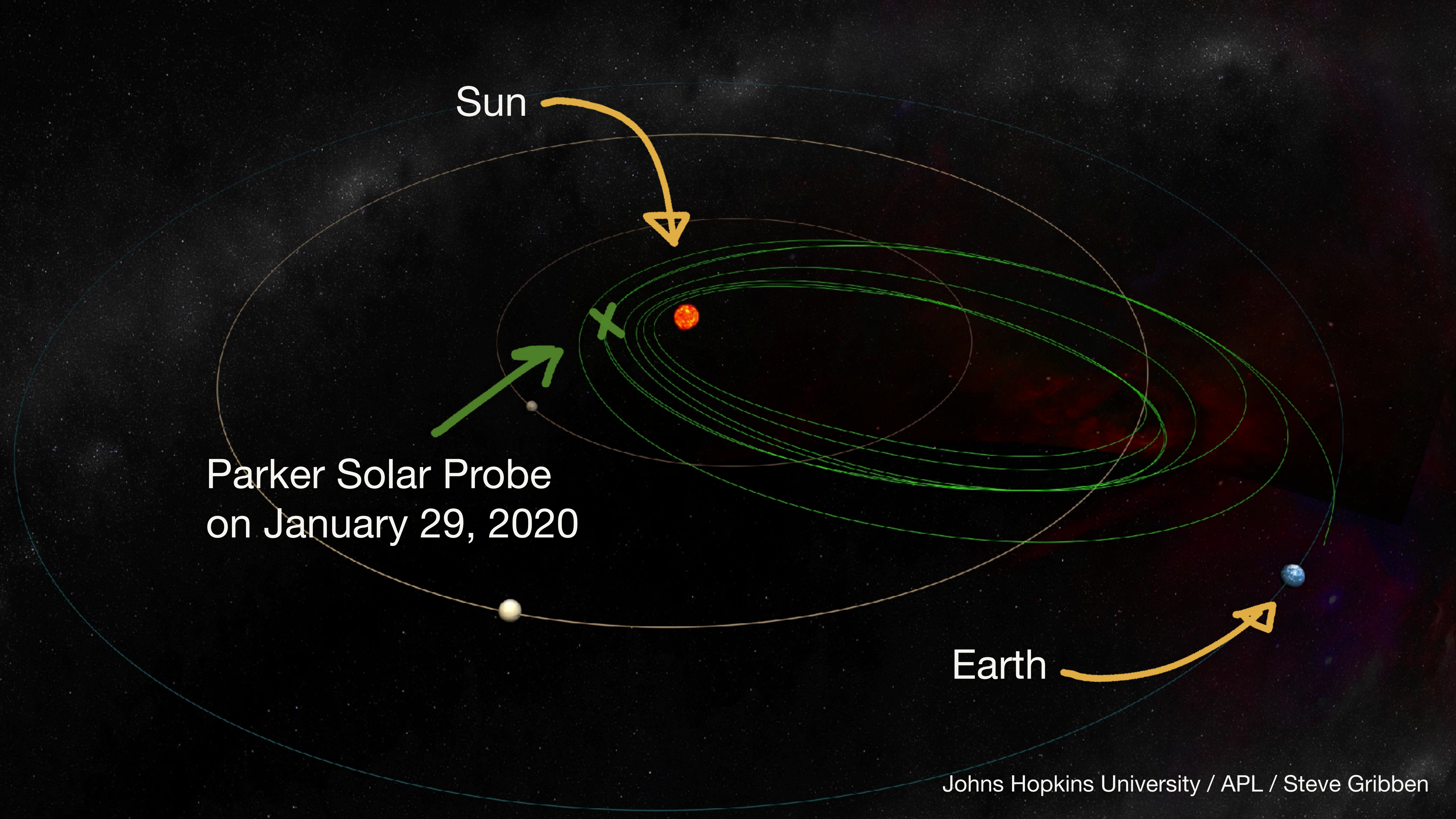


time series



*in situ*

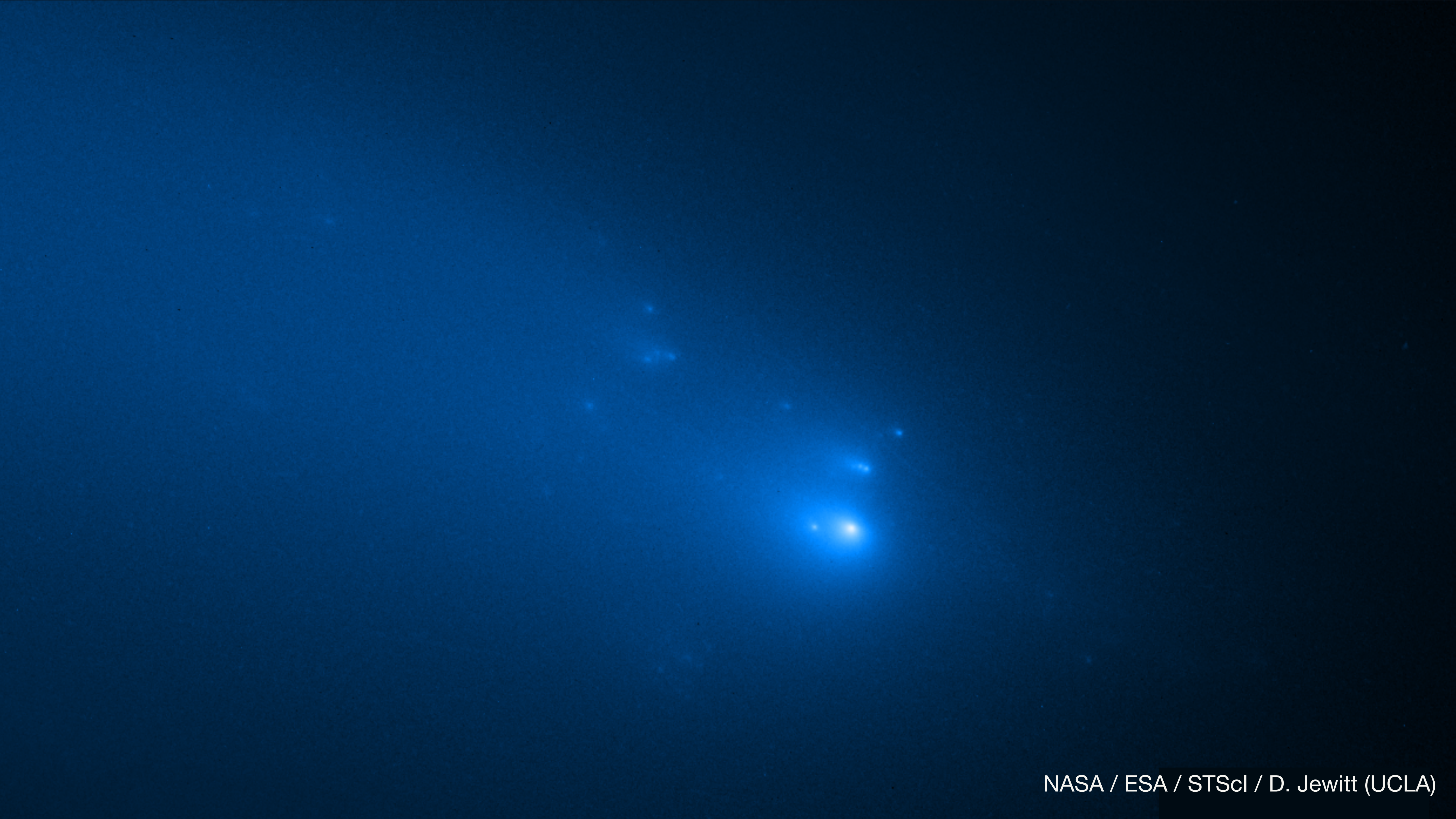




Sun

Parker Solar Probe  
on January 29, 2020

Earth

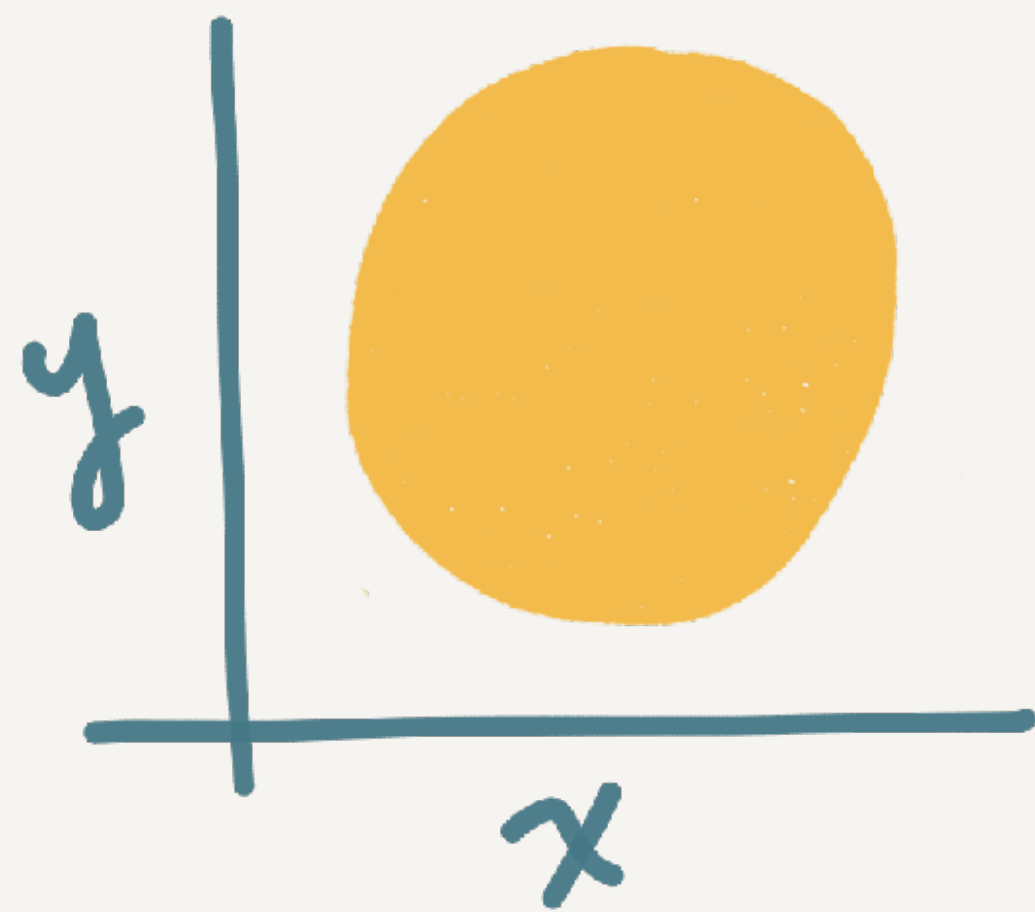




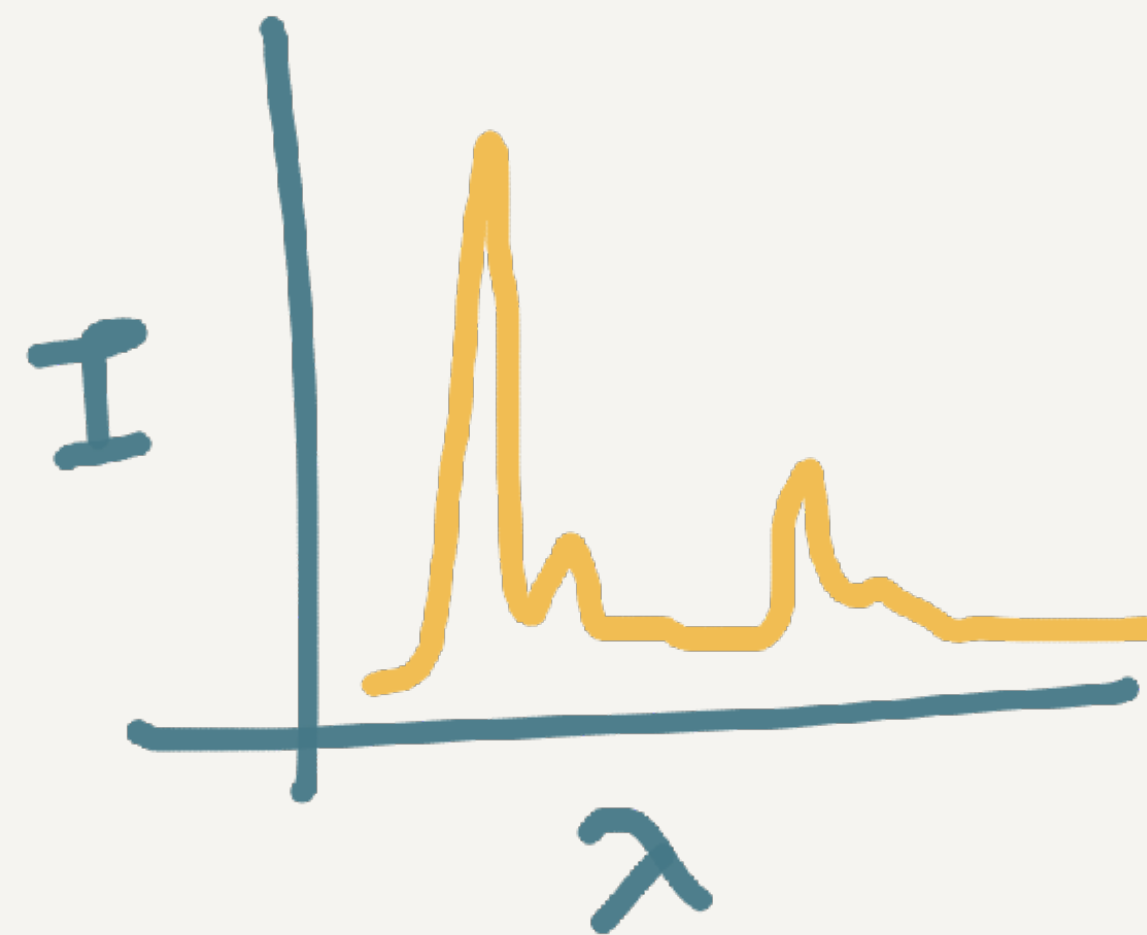
# NASA: 6 space-based solar missions

# NSF: 10 ground-based facilities

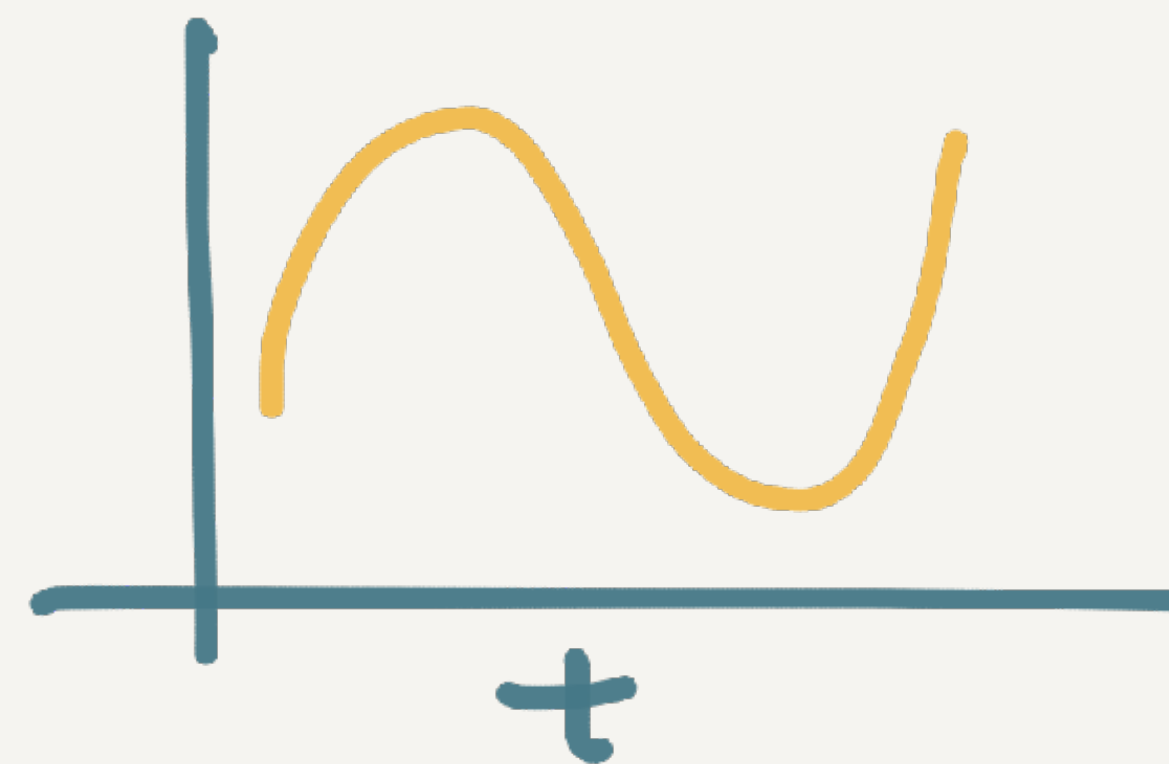
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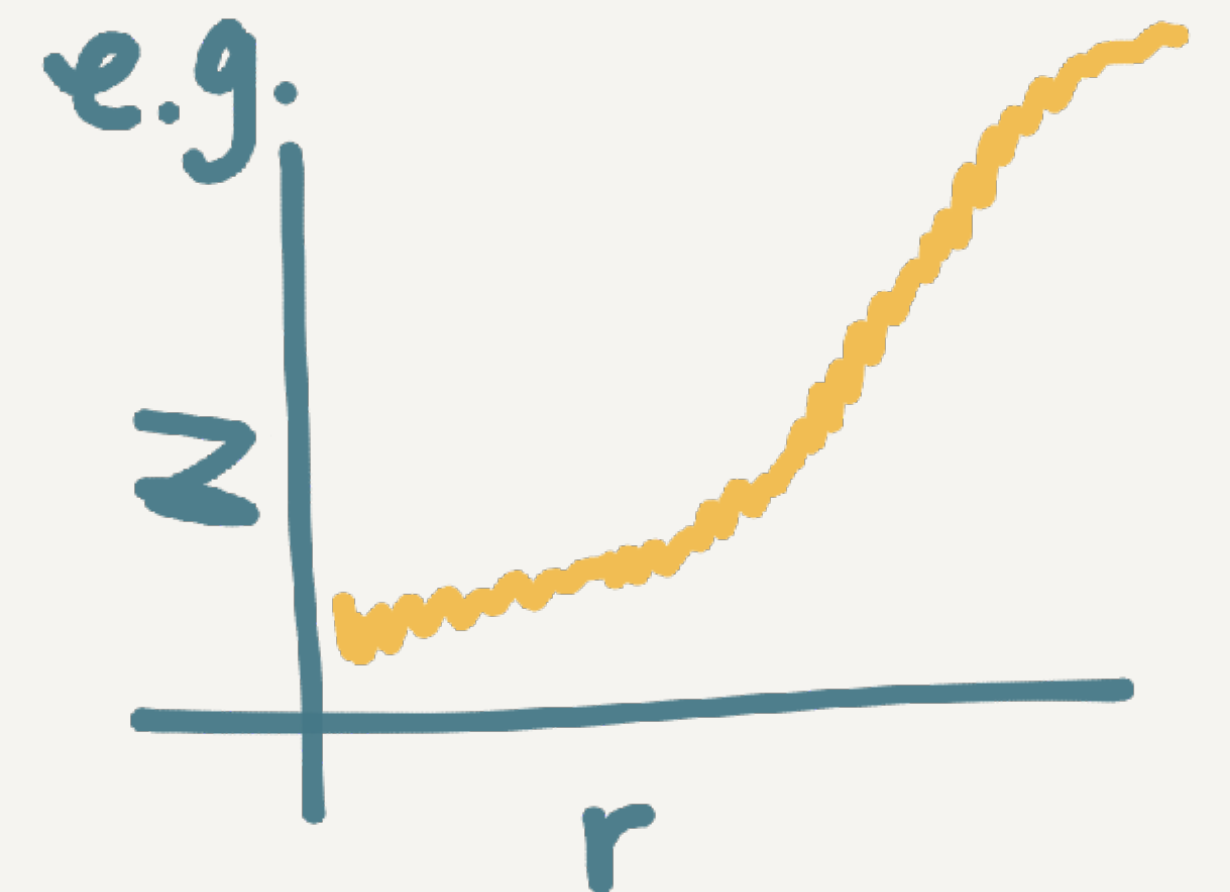
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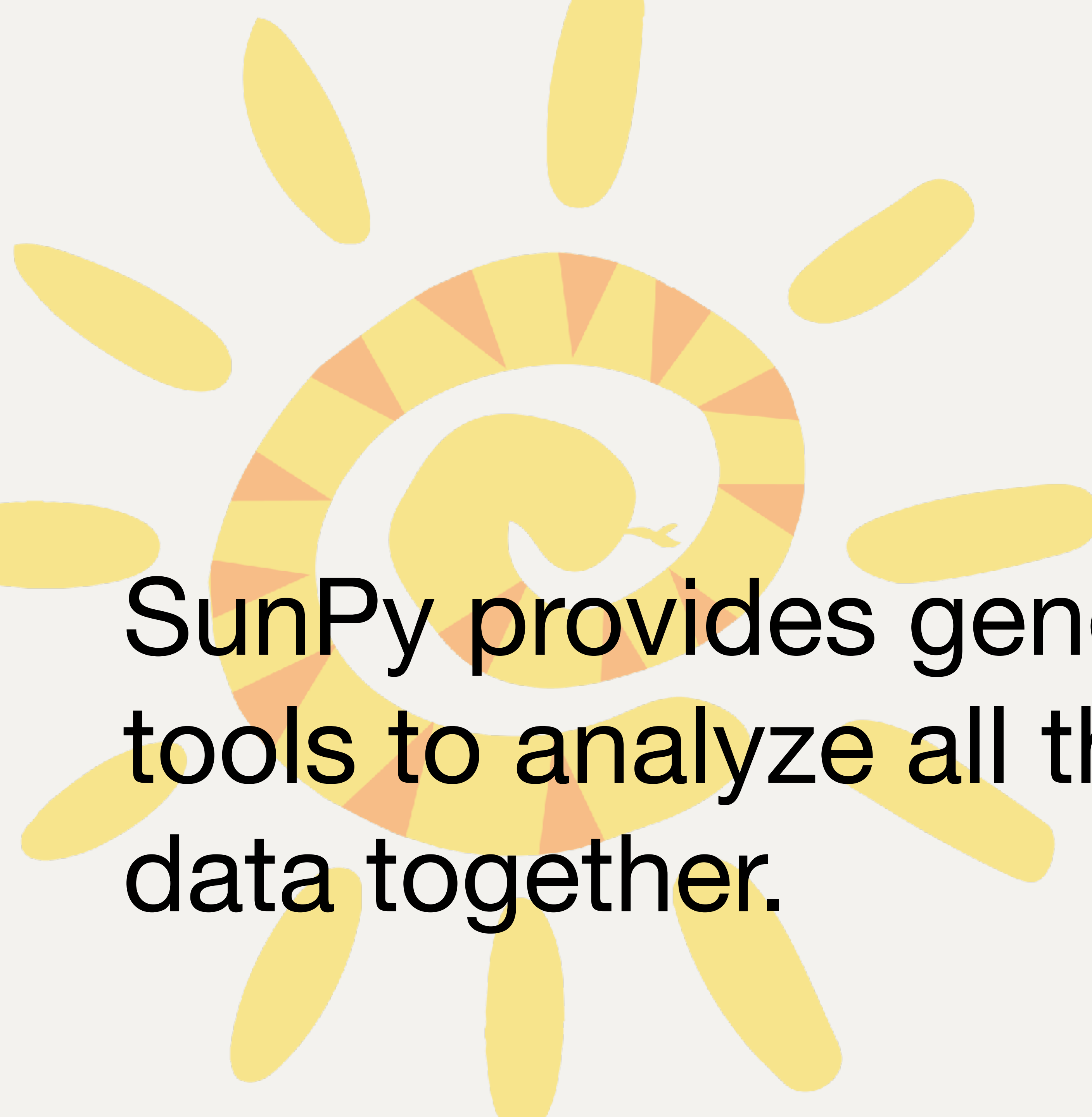


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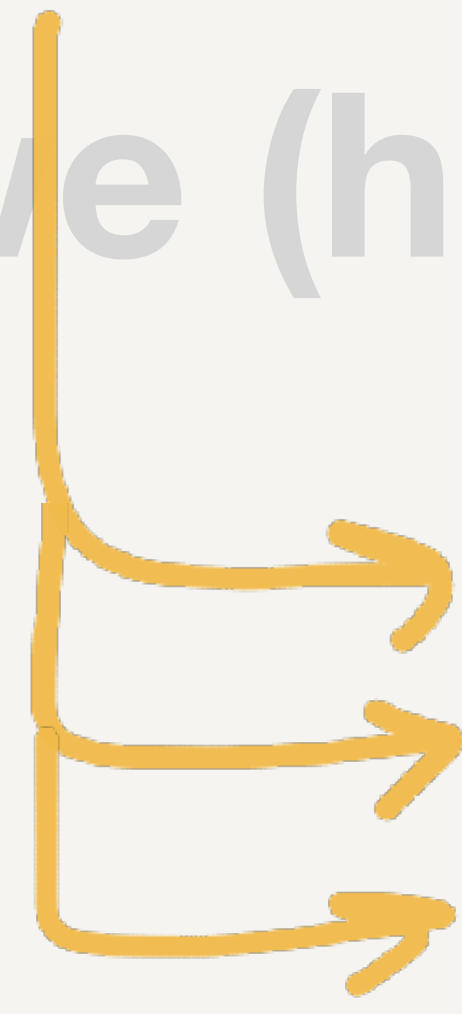


**SunPy provides general-purpose tools to analyze all these disparate data together.**

Why do we need SunPy?

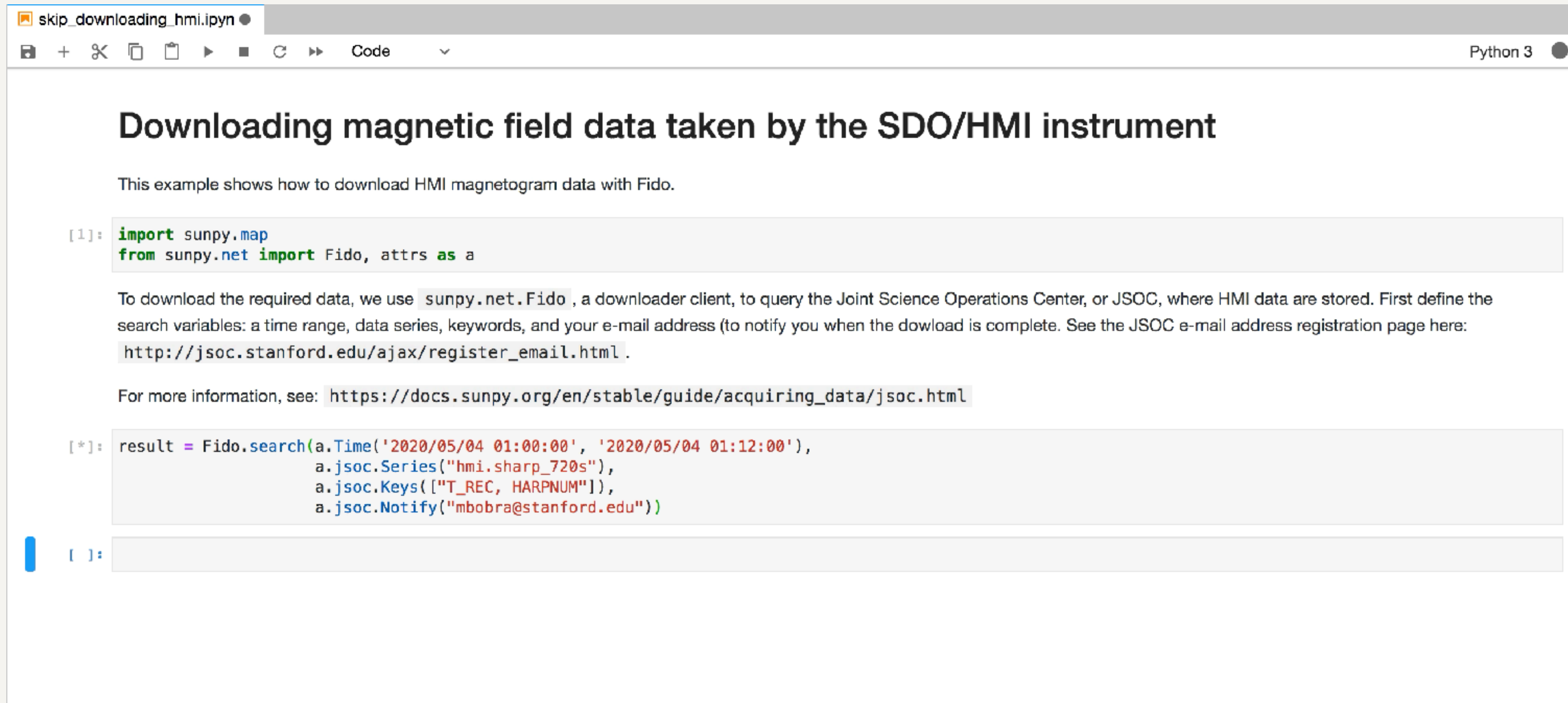
## **What's in SunPy v2.0?**

How did we (hopefully) gain visibility?

- 
- Data retriever
  - Data containers
  - Coordinate systems

# Data Retriever: Fido

A 200-line Python script that simplifies downloading solar data



The screenshot shows a Jupyter Notebook interface with the following content:

## Downloading magnetic field data taken by the SDO/HMI instrument

This example shows how to download HMI magnetogram data with Fido.

```
[1]: import sunpy.map
      from sunpy.net import Fido, attrs as a
```

To download the required data, we use `sunpy.net.Fido`, a downloader client, to query the Joint Science Operations Center, or JSOC, where HMI data are stored. First define the search variables: a time range, data series, keywords, and your e-mail address (to notify you when the download is complete. See the JSOC e-mail address registration page here: [http://jsoc.stanford.edu/ajax/register\\_email.html](http://jsoc.stanford.edu/ajax/register_email.html)).

For more information, see: [https://docs.sunpy.org/en/stable/guide/acquiring\\_data/jsoc.html](https://docs.sunpy.org/en/stable/guide/acquiring_data/jsoc.html)

```
[*]: result = Fido.search(a.Time('2020/05/04 01:00:00', '2020/05/04 01:12:00'),
                          a.jsoc.Series("hmi.sharp_720s"),
                          a.jsoc.Keys(["T_REC", "HARPNUM"]),
                          a.jsoc.Notify("mbobra@stanford.edu"))
```

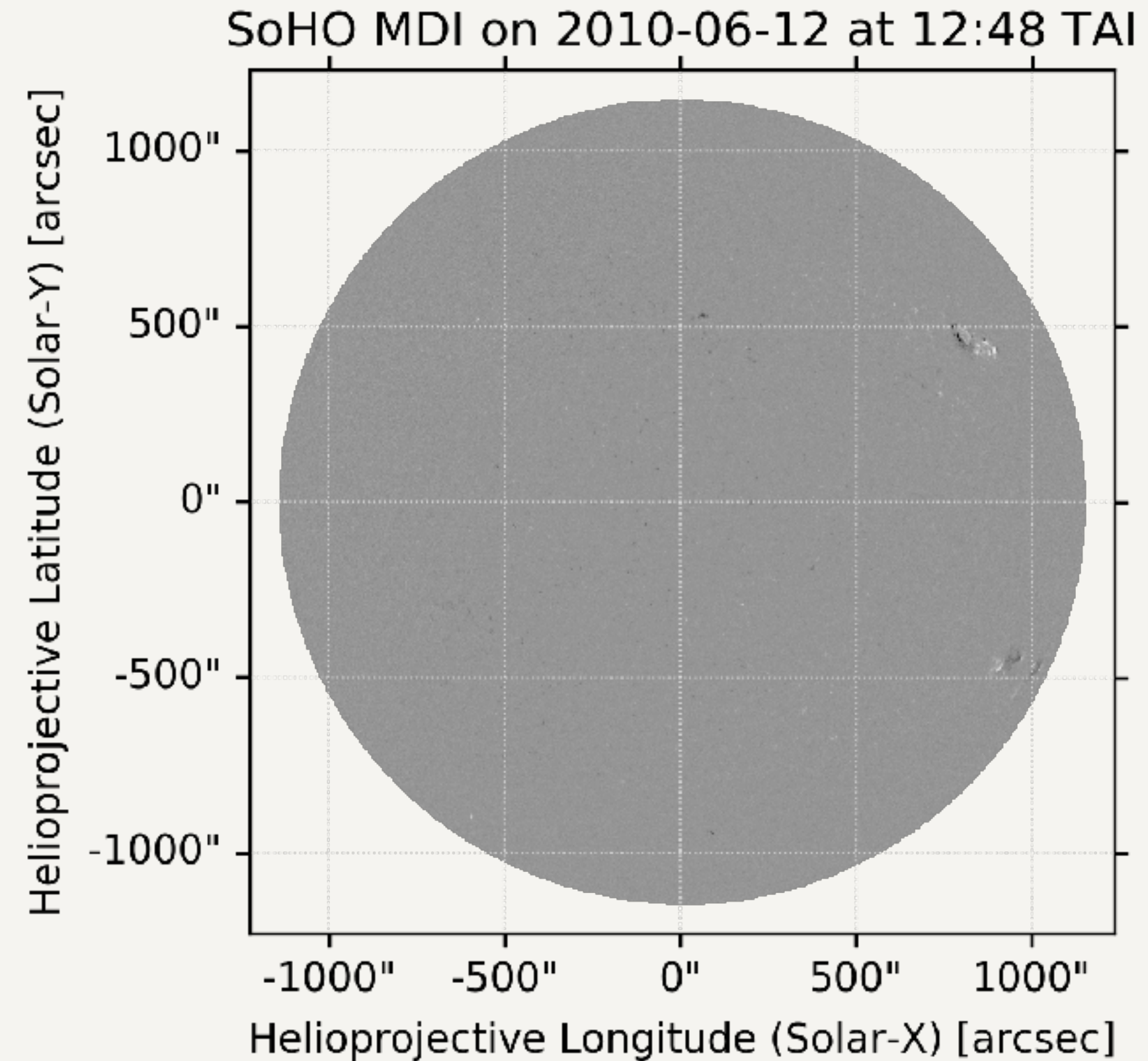
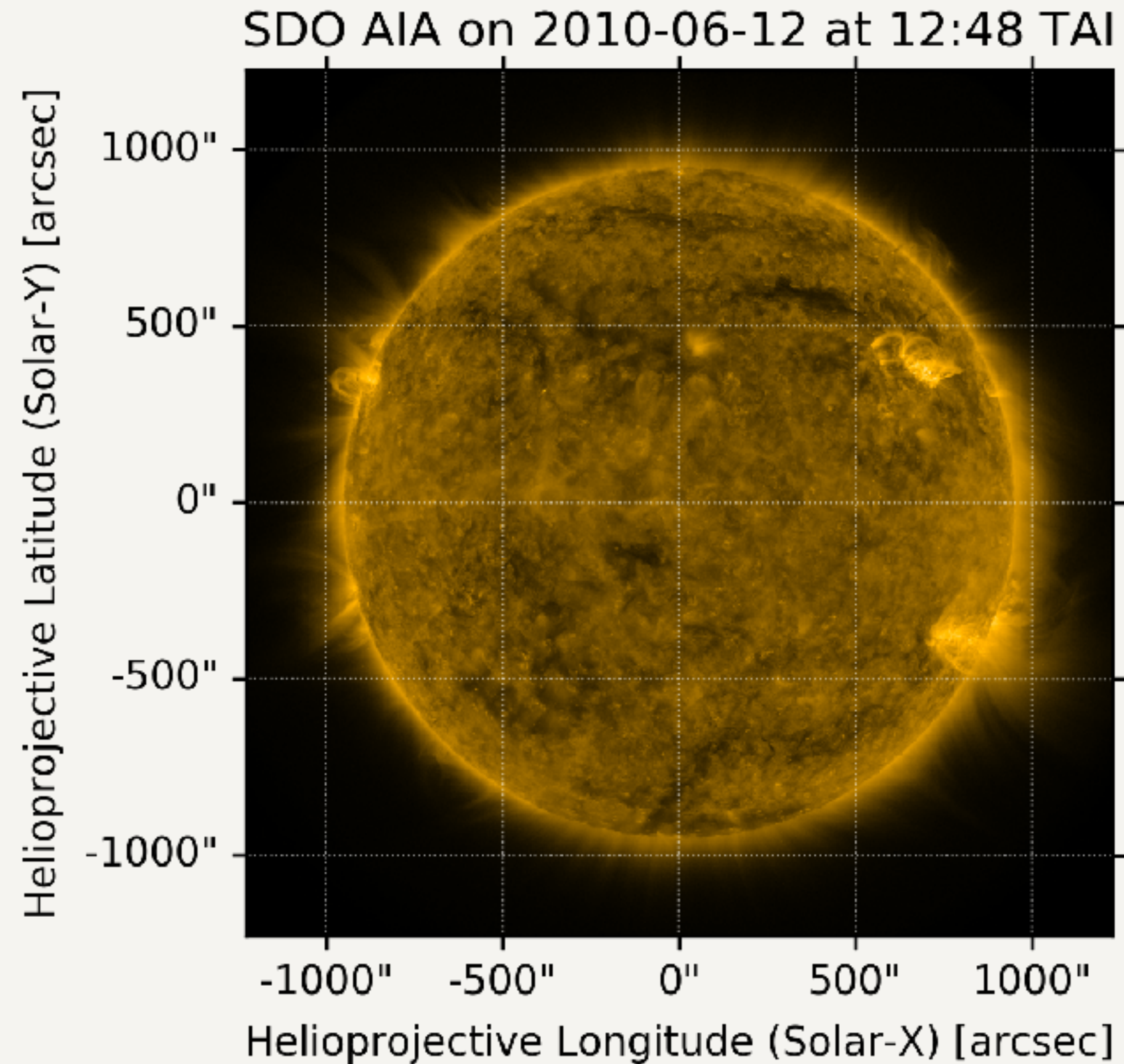
```
[ ]:
```

# Data Containers

A general, standard, and consistent interface for analyzing data

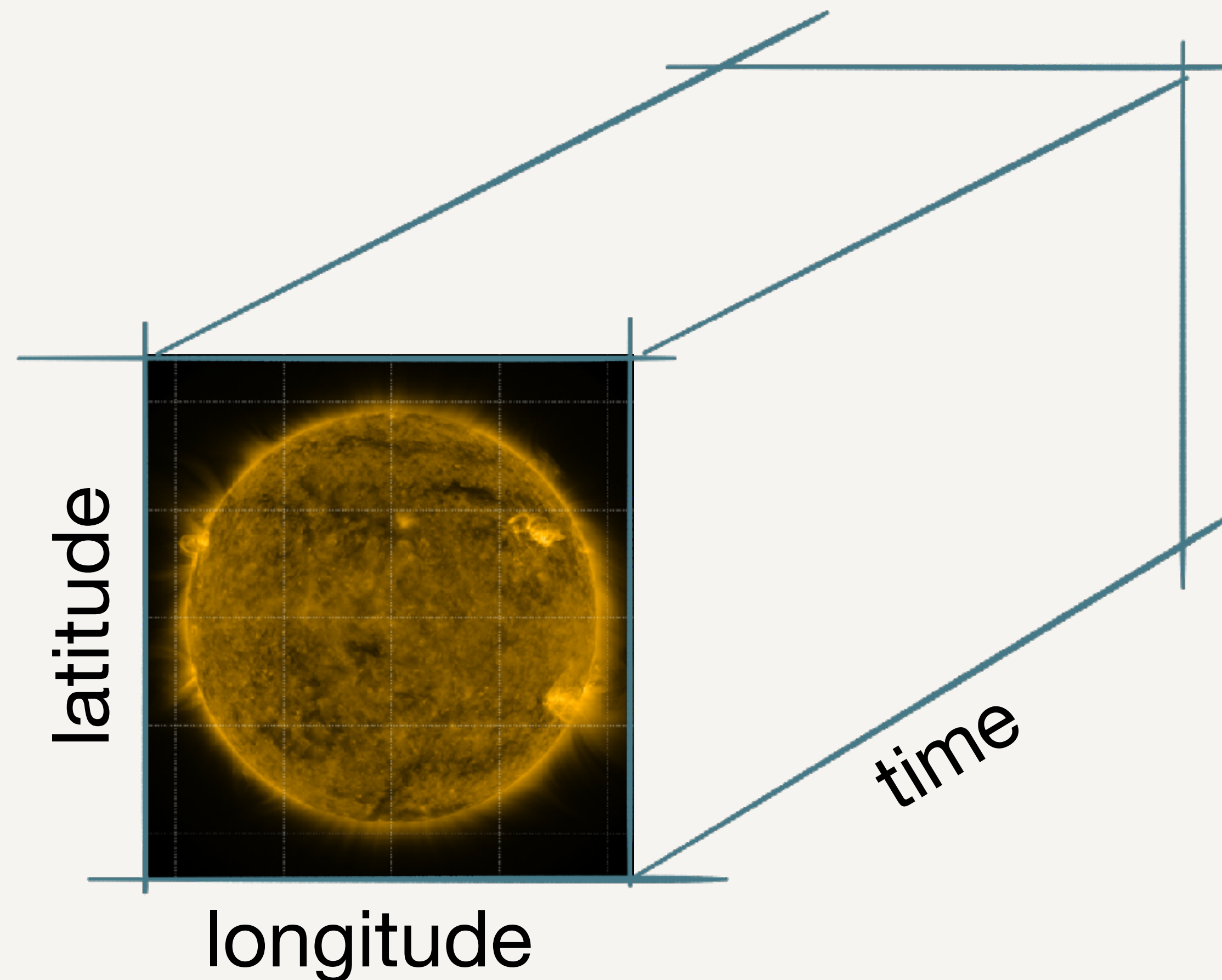
# Data Containers

v2.0: Map object includes new methods to produce graphical overviews



# Data Containers

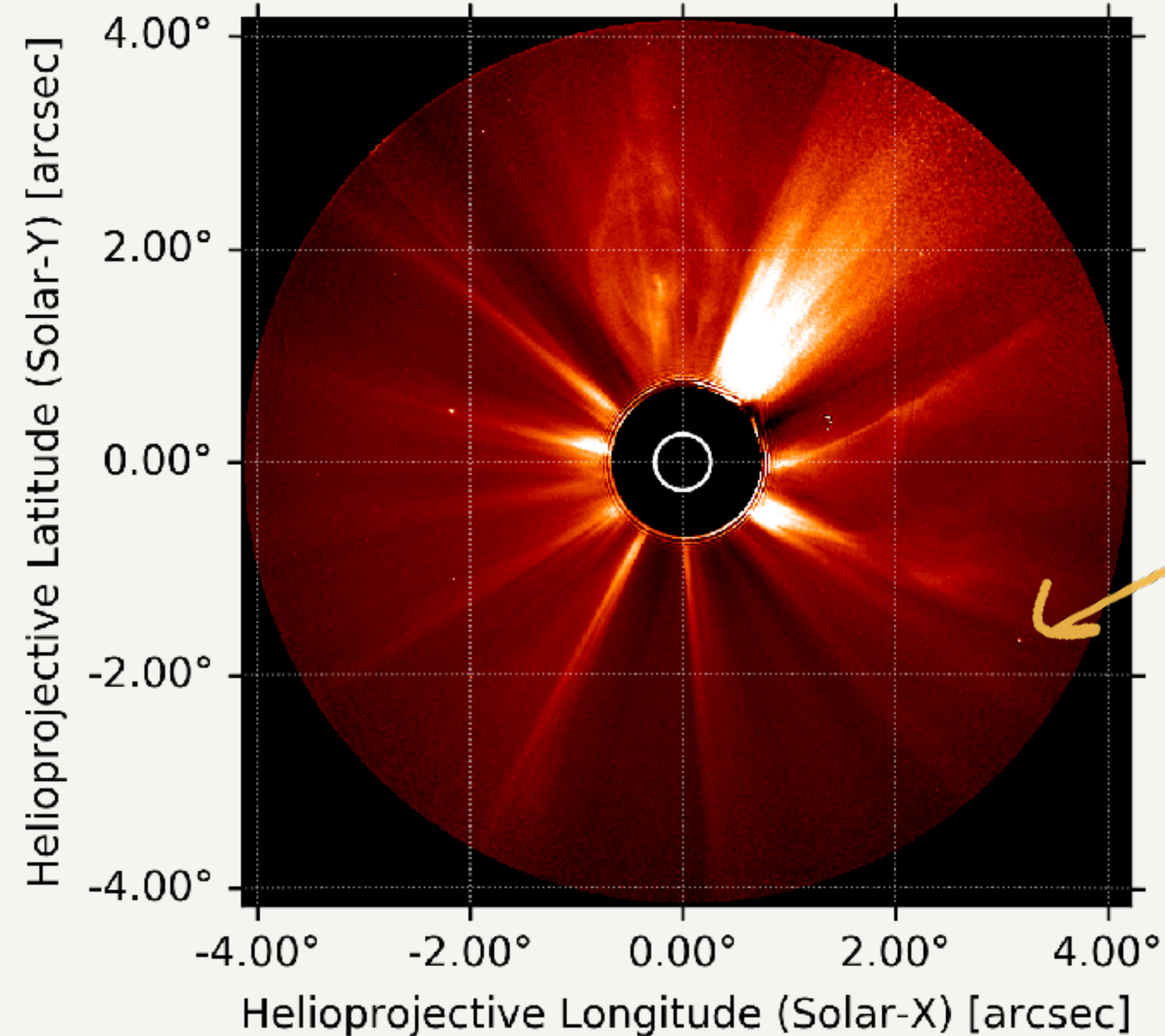
v3.0 planned upgrade to N-dimensional coordinate-aware Map object



# Coordinate systems

A way to transform data between many coordinate systems

STEREO SECCHI COR2 on 2014-05-15 at 07:54:00 UT

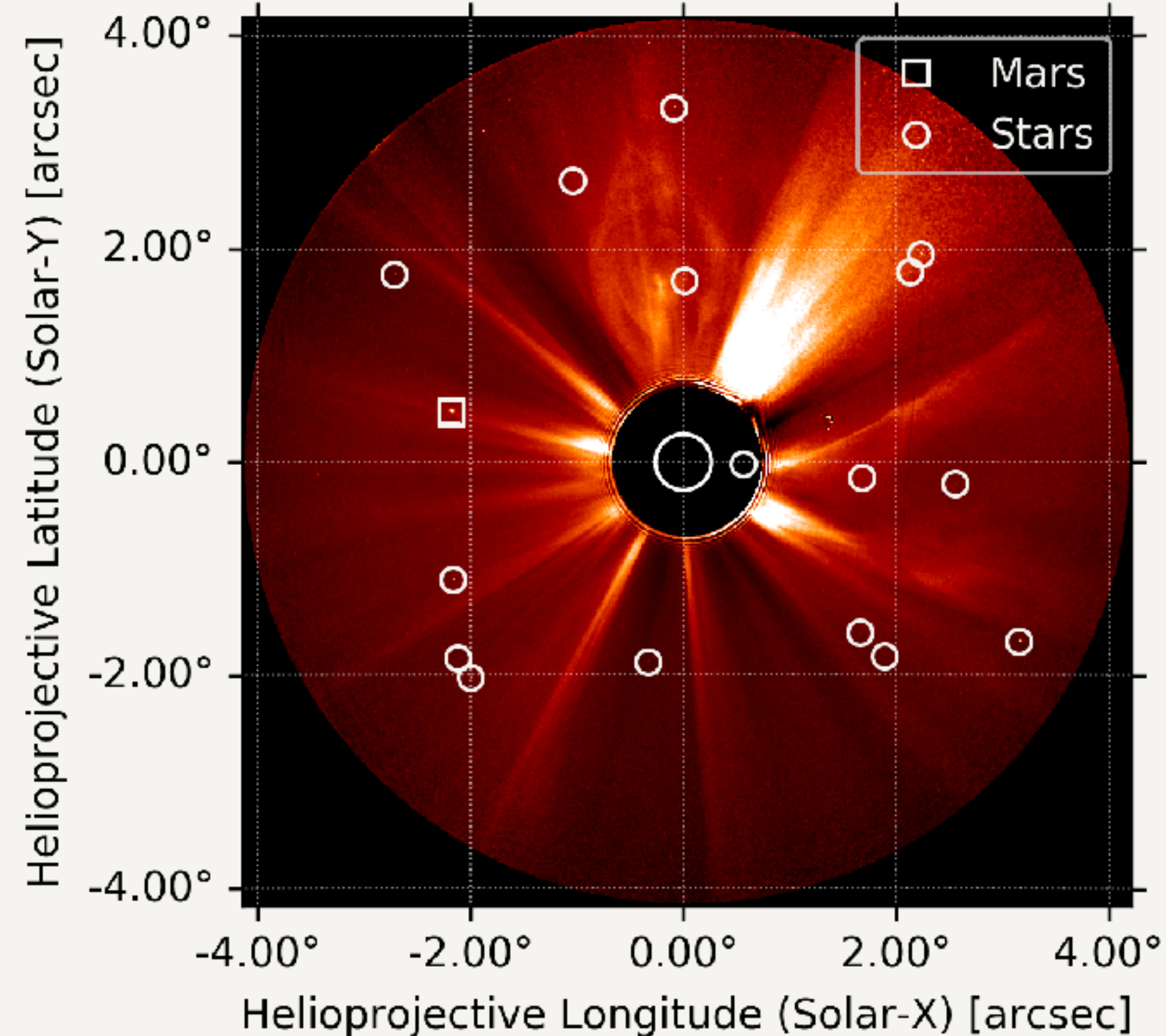




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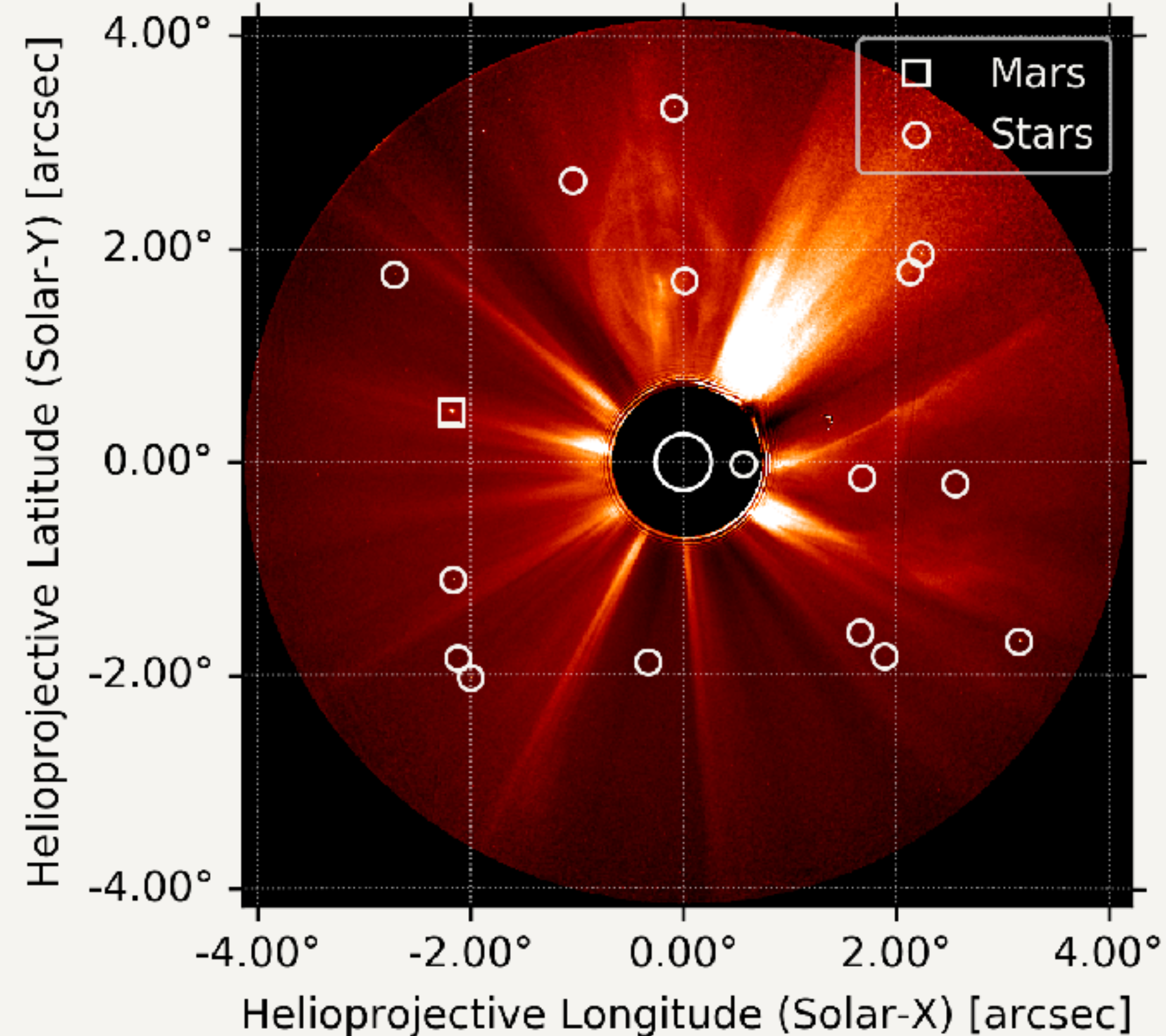
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# Coordinate systems

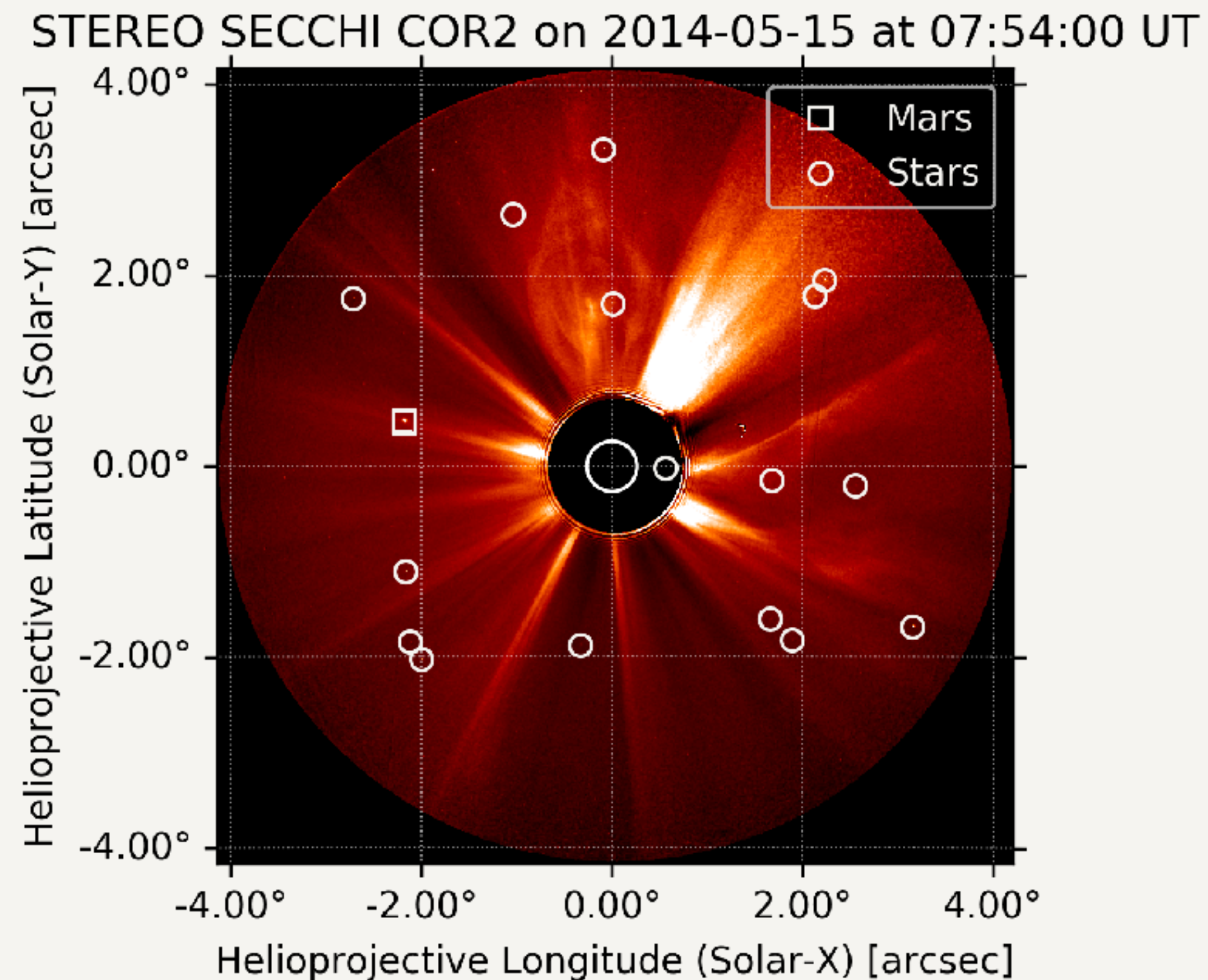
v1.0: Improved precision of transformations + tooling for small bodies

STEREO SECCHI COR2 on 2014-05-15 at 07:54:00 UT



# Coordinate systems

v2.0: Improved our treatment of differential rotation



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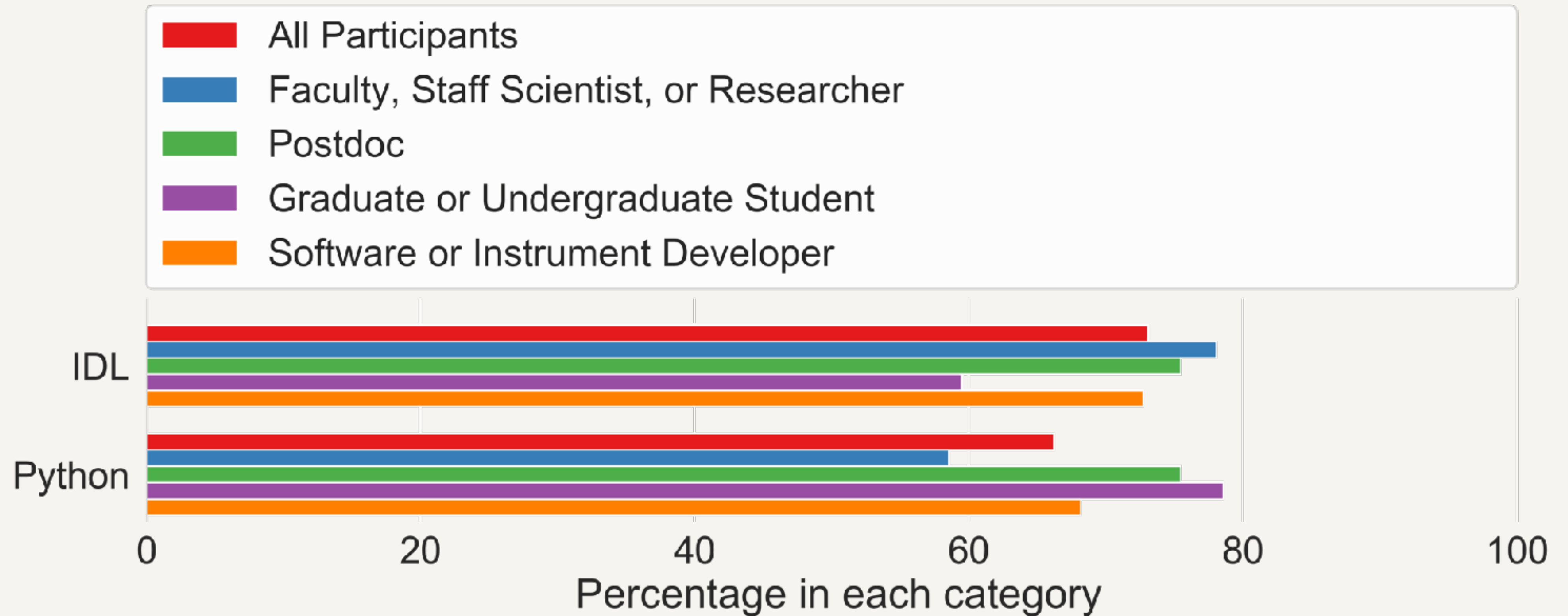
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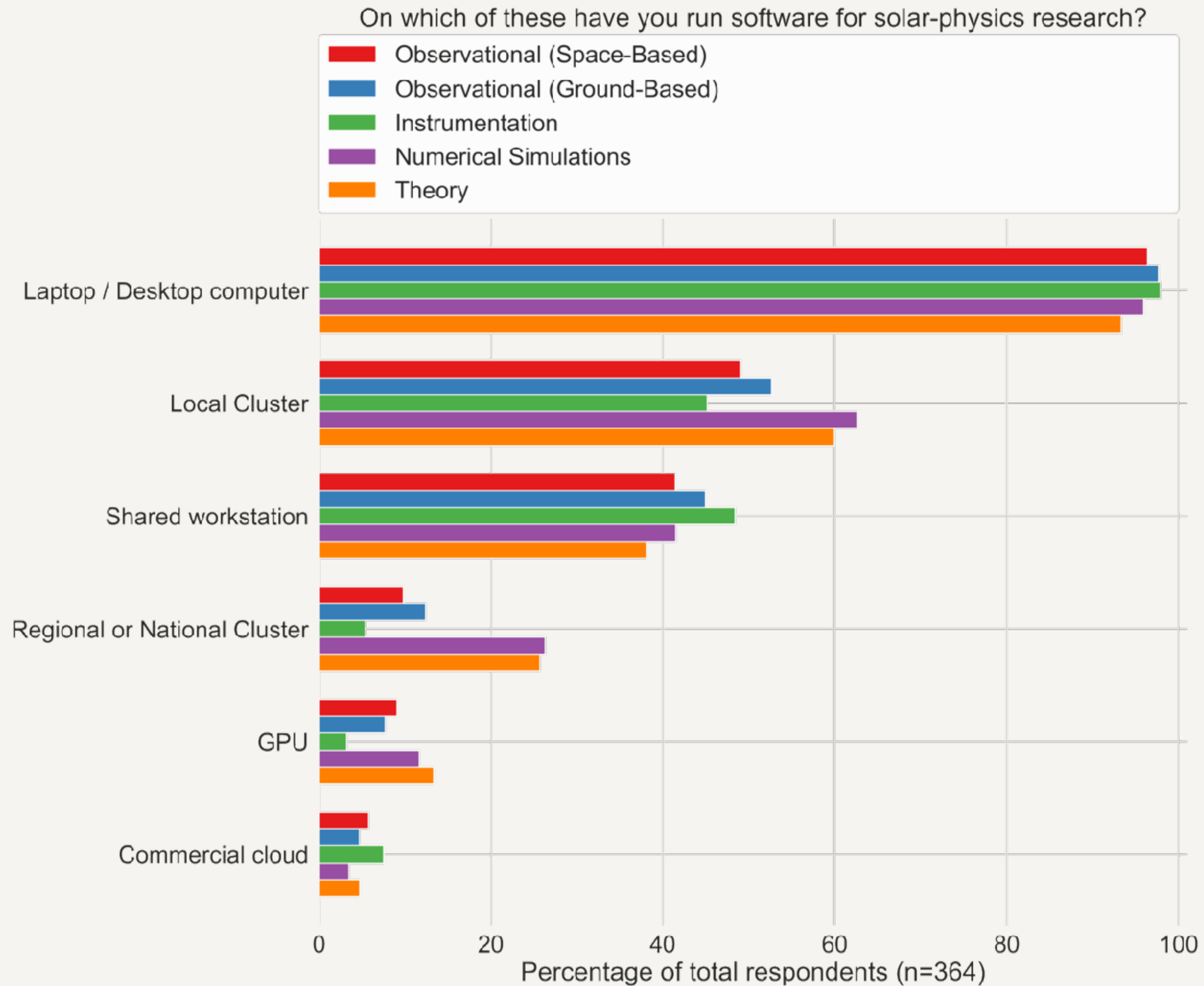
# How did we (hopefully) gain visibility?



# Community survey

Which of the following have you personally utilized in your work within the last year?





# Papers

The SunPy Community, Will T. Barnes, Monica G. Bobra, et al. *The SunPy Project: Open Source Development and Status of the Version 1.0 Core Package*. 2020, *The Astrophysical Journal*, 890, 1.

+

Stuart J. Mumford, Nabil Freij, Steven Christe, et al. *SunPy: A Python package for Solar Physics*. 2020, *Journal of Open Source Software*, 5(46), 1832.



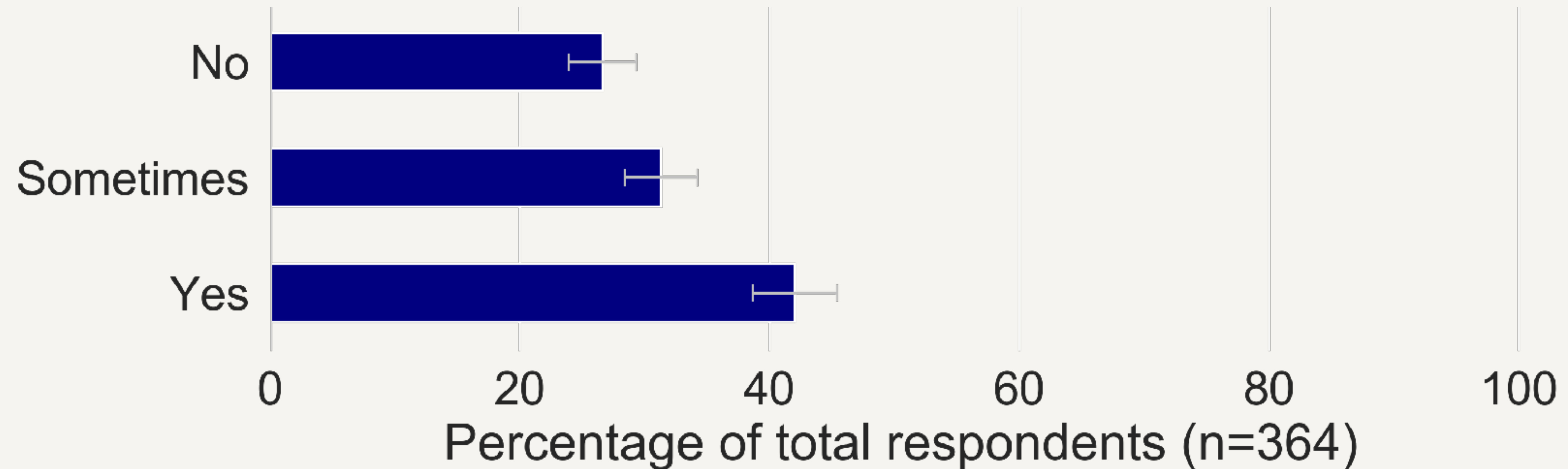
# Papers

How did publishing papers help us?

1. We were formally recognized for scientific merit.
2. It gave us the opportunity to tell the community what we're trying to do. And to clarify these ideas to ourselves.
3. It gave people something to cite.

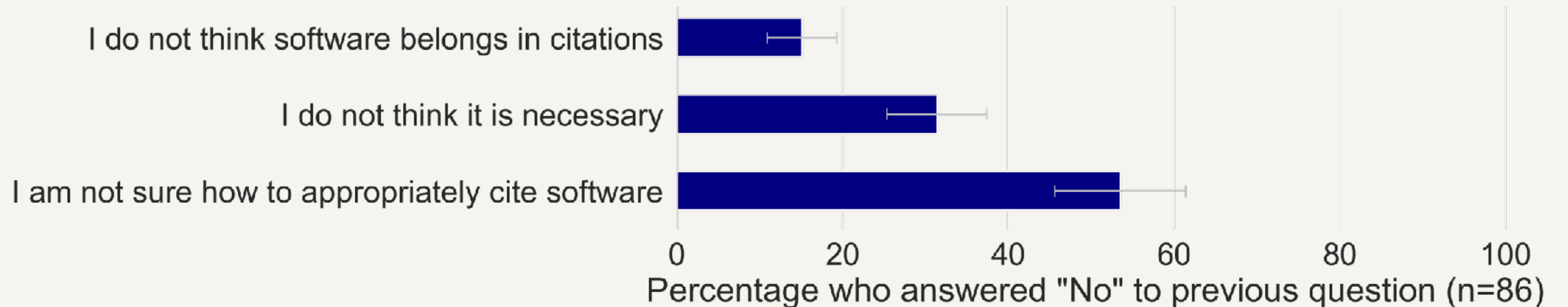
# Citations

Have you cited software papers in your published research?



# Citations

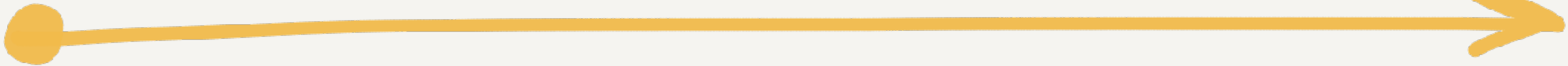
Why haven't you cited software in your research?



# Funding

We won a NASA grant!

**June 2018**



NASA opened a solicitation  
"to advance the goal of a  
robust, vital, and cohesive  
Python environment in  
Heliophysics."

# Funding

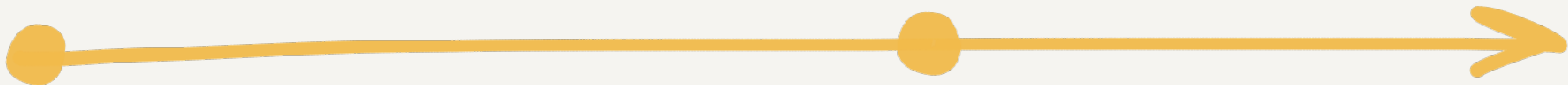
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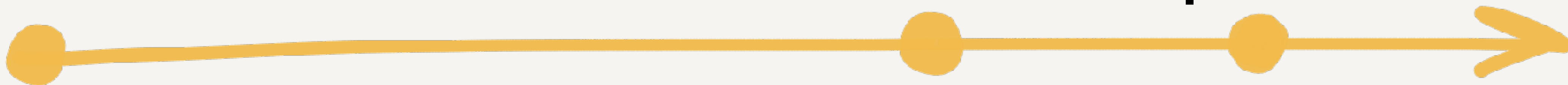
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**October 2019**

We were selected!

**April 2020**

The SunPy Project decided to spend the money by hiring a developer.



# Funding

Create opportunities

1. Talk to people at funding agencies.
2. Show them examples of awesome, new research that relies on open source scientific software.

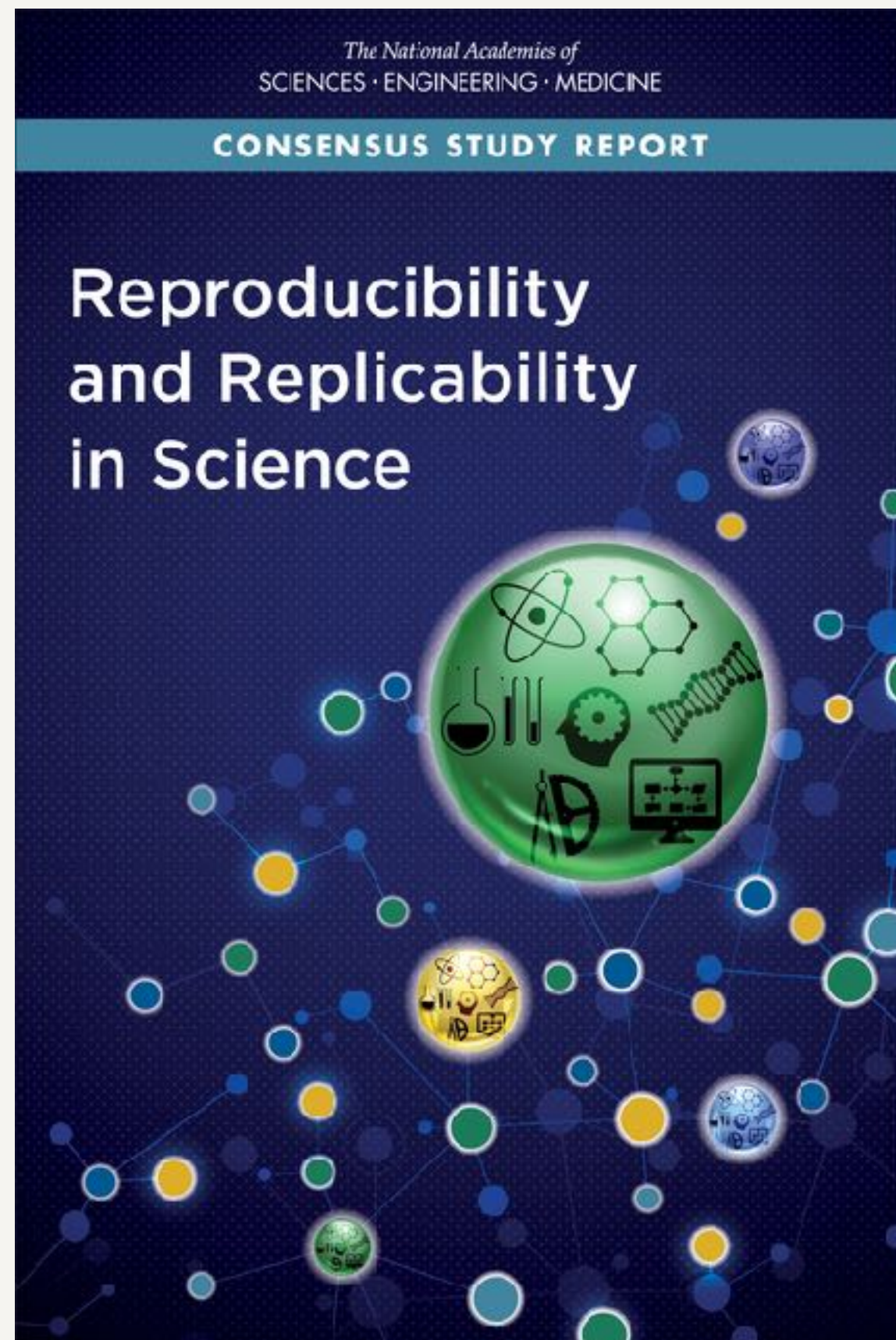
# How did we (hopefully) gain visibility?



New science policies

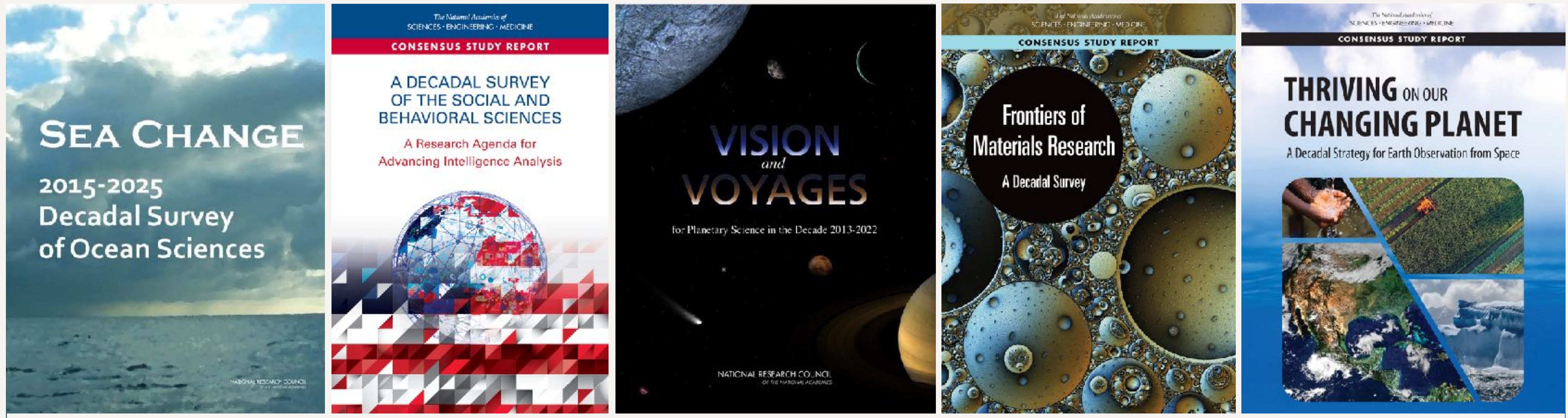


# Science Policy



**"Recommendation 6-3:** Funding agencies and organizations should consider investing in research and development of open-source, usable tools and infrastructure that support reproducibility for a broad range of studies across different domains in a seamless fashion."

# Science Policy



National Research Council. 2015. *Sea Change: 2015-2025 Decadal Survey of Ocean Sciences*.

National Academies of Sciences, Engineering, and Medicine. 2019. *A Decadal Survey of the Social and Behavioral Sciences: A Research Agenda for Advancing Intelligence Analysis*.

National Research Council. 2011. *Vision and Voyages for Planetary Science in the Decade 2013-2022*.

National Academies of Sciences, Engineering, and Medicine. 2019. *Frontiers of Material Research: A Decadal Survey*.

National Academies of Sciences, Engineering, and Medicine. 2018. *Thriving on Our Changing Planet: A Decadal Strategy for Earth Observation from Space*.

# Python in Heliophysics Community (PyHC)

Promoting and facilitating the use and development of Python for Heliophysics.