

# On Your Turn

On your turn, you can do one of three actions:



## Pick Telescope

Choose a Telescope Card from the center and add it to your hand.



## Observe Data

Use a Telescope Card to pick up any Observation from the center and add it to one of your Science Goals.



## Unleash Chaos

Draw a Chaos Card and resolve its effects.

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# Data Types



## Image

A picture captured through a telescope.



## Spectrum

The brightness of an object as measured over a range of wavelengths (colors).



## Timeseries

A series of measurements which shows how an astronomical object changes over time.



## Catalog

A large table of calculations and other properties taken from astronomical data.

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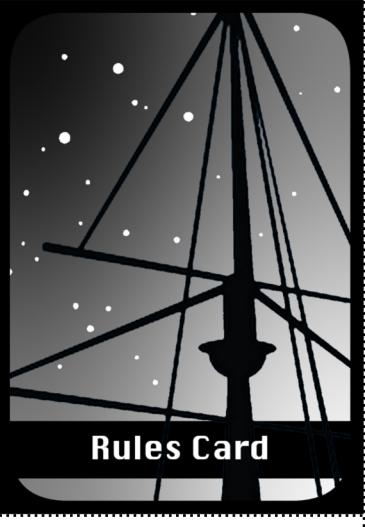
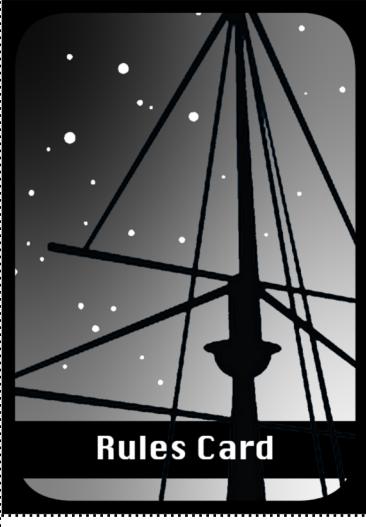
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# How to Play



<https://github.com/spacetelescope/mast-match/>

Scan the QR Code above to read the rules and learn how to play MAST Match.



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## Target Types



### Galaxy

A huge collection of gas, dust, and billions of stars all held together by gravity.



### Star

Giant spheres of hot plasma, mostly made of hydrogen and helium.



### Nebula

Giant clouds of dust and gas in space.



### Planet

A celestial body that orbits around a star.

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## GALEX - SPACE TELESCOPE -



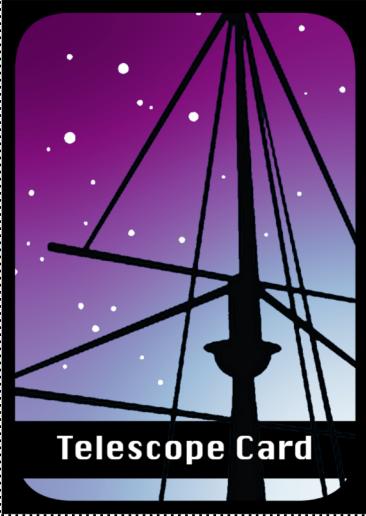
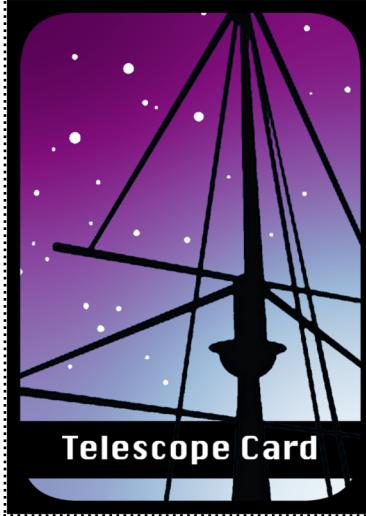
Ultraviolet Telescope

## Hubble - SPACE TELESCOPE -



Ultraviolet Telescope

Optical Telescope



# **James Webb**

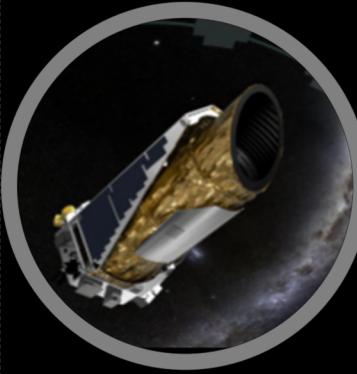
- SPACE TELESCOPE -



Infrared Telescope

# **Kepler**

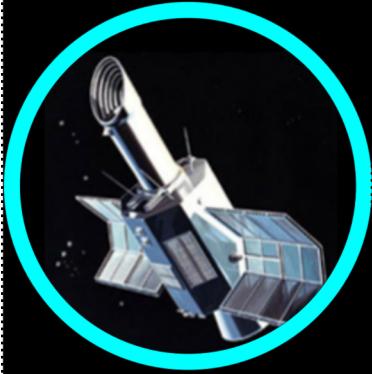
- SPACE TELESCOPE -



Optical Telescope

# **IUE**

- SPACE TELESCOPE -



Ultraviolet Telescope

# **TESS**

- SPACE TELESCOPE -



Optical Telescope

# **Spitzer**

- SPACE TELESCOPE -



Infrared Telescope

# **Roman**

- SPACE TELESCOPE -



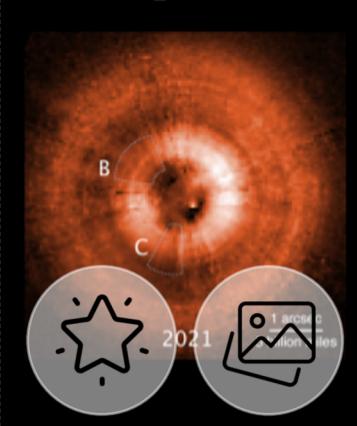
Optical Telescope

Infrared Telescope

## **Exoplanet Kepler-16b**



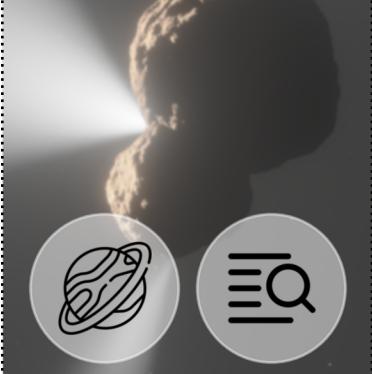
## **TW Hydrae**



2021



## **Centaur 29P**





**Telescope Card**



**Telescope Card**



**Telescope Card**



**Telescope Card**



**Telescope Card**



**Telescope Card**



**Observation Card**



**Observation Card**



**Observation Card**

## Stephan's Quintet



## Serpens Cluster



## Butterfly Nebula



## Andromeda Galaxy



## NGC 1566



## PLCK G165.7



## Horsehead Nebula



## Pillars of Creation



## Dark Nebula





## Observation Card



## Observation Card



## Observation Card



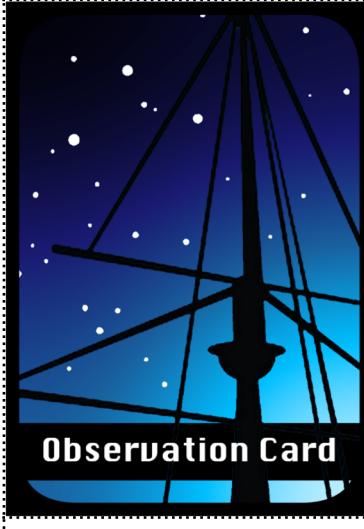
## Observation Card



## Observation Card



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## Observation Card



## **Observation Card**



## **Observation Card**

## Messier 92



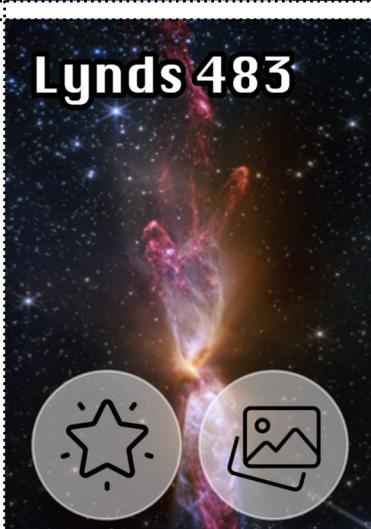
## Exoplanet WASP 107-b



## Mars



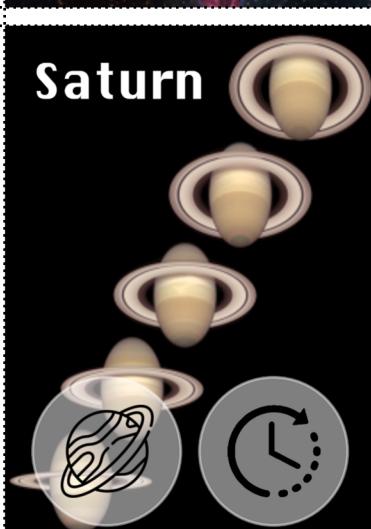
## Lynds 483



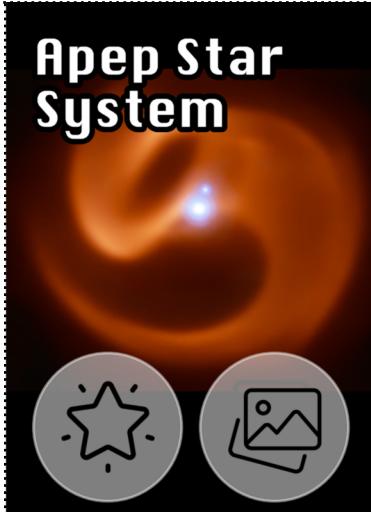
## Sagittarius C



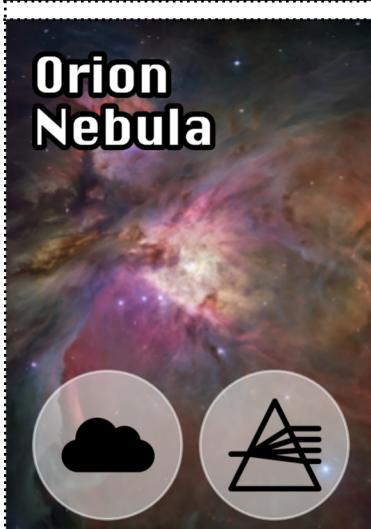
## Saturn



## Apep Star System



## Orion Nebula



## NGC 1514





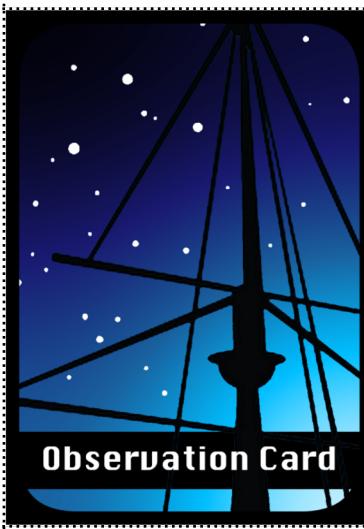
# Observation Card



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## **Observation Card**



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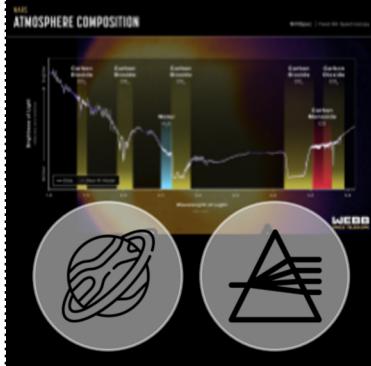
# NGC 376



# Galaxy Merger ZW-096



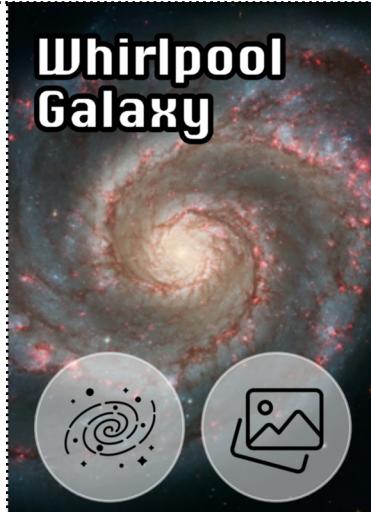
# Martian Atmosphere



# Orion Bar



# Whirlpool Galaxy



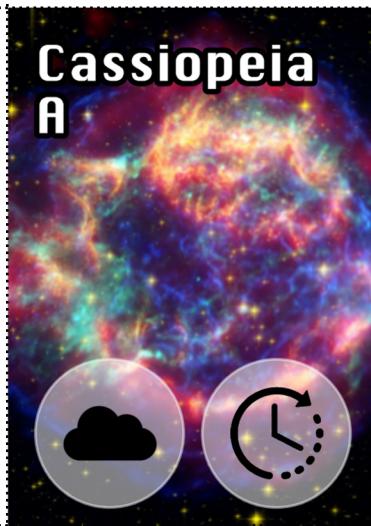
# Tarantula Nebula



# Exoplanet GJ-386b



# Cassiopeia A





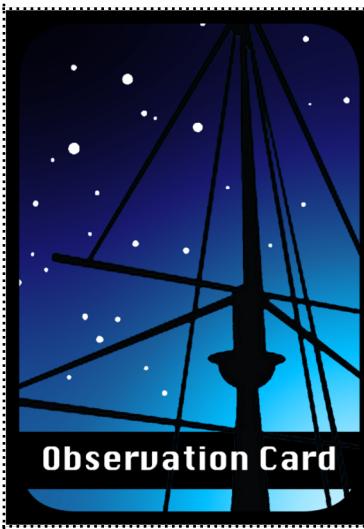
## Observation Card



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## **Observation Card**



## **Observation Card**



## **Observation Card**

## Westerlund 2

## Andromeda Galaxy

## Hercules Cluster



## Sombrero Galaxy

## Neptune

## Ring Nebula



## Herbig-Haro Object

## Moons of Jupiter

## Planetary Disk





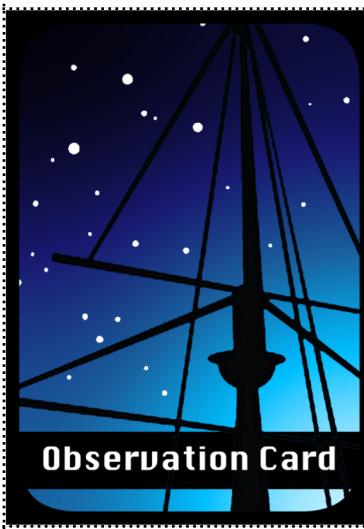
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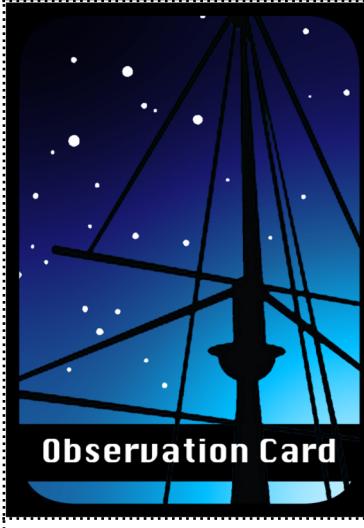
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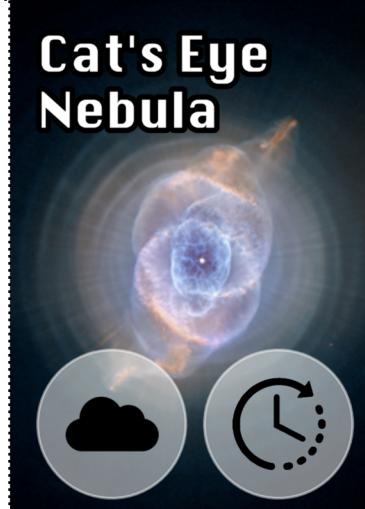


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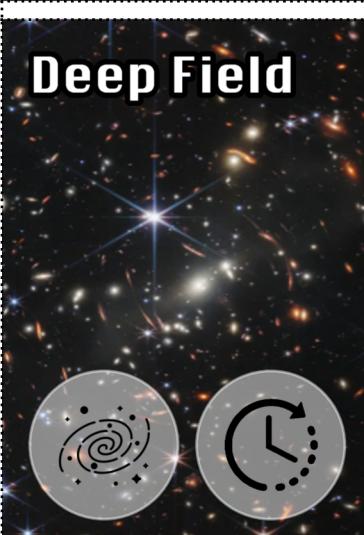
## CW Leonis



## Cat's Eye Nebula



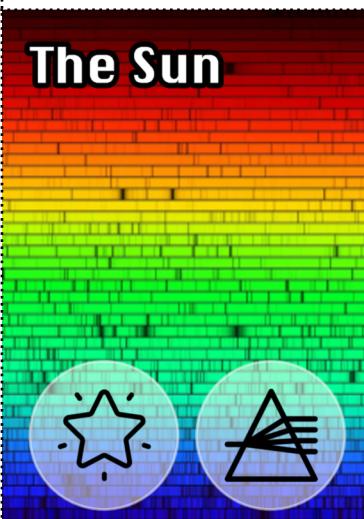
## Deep Field



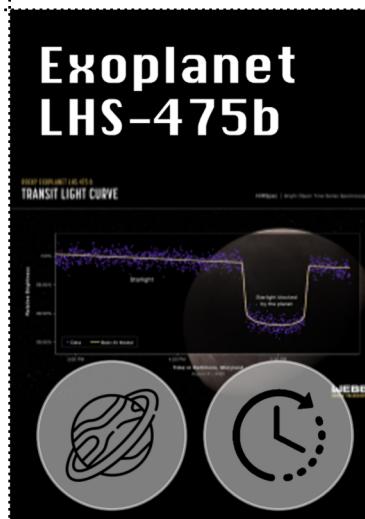
## AG Carinae



## The Sun



## Exoplanet LHS-475b



## Messier 101



## Arp 142



## NGC 1087





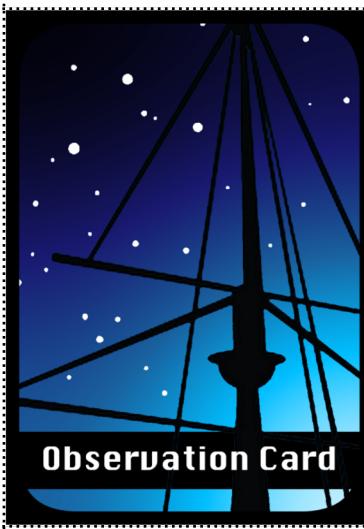
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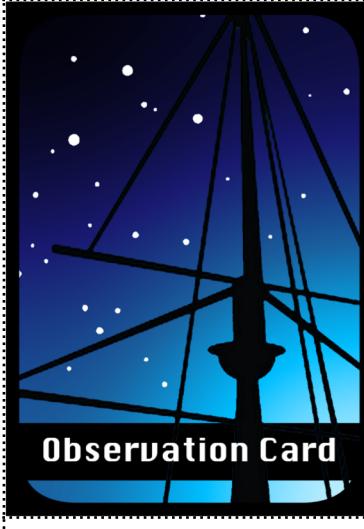
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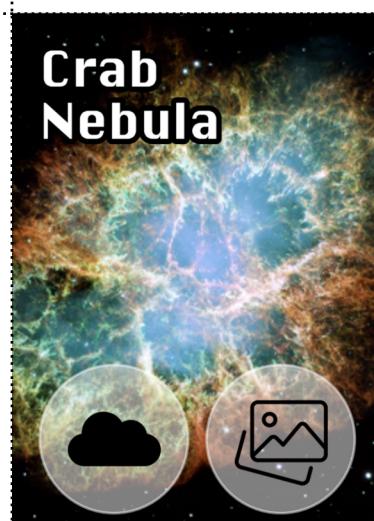


## Observation Card

## Vega



## Crab Nebula



## Rho Ophiuchi



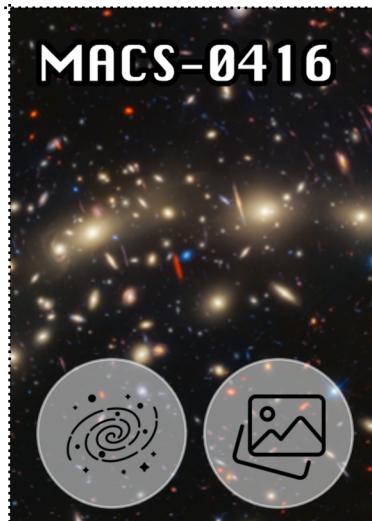
## NGC 2207



## M81 and M82



## MACS-0416



## Flame Nebula





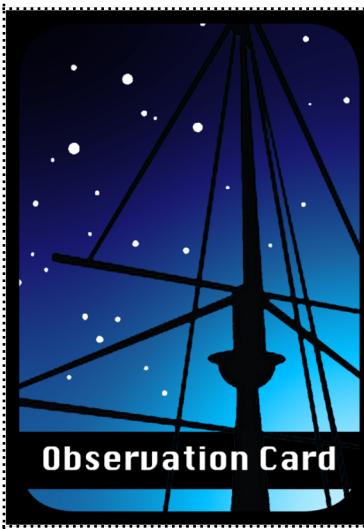
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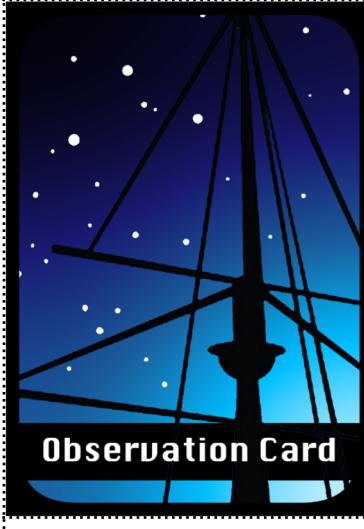
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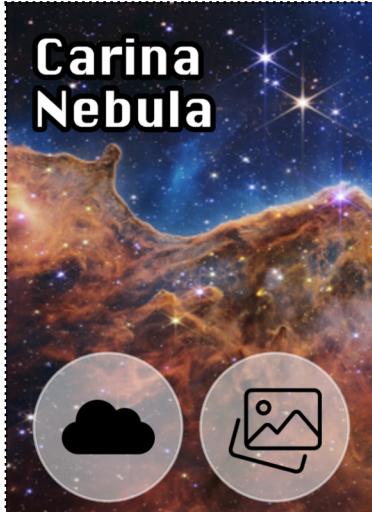


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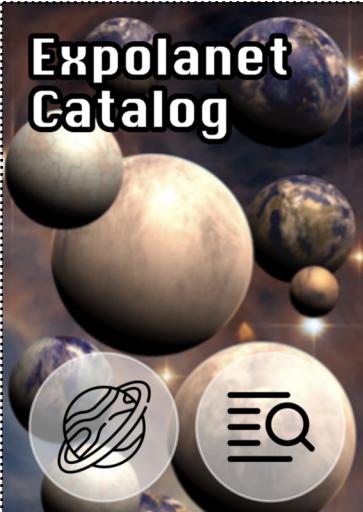


## **Observation Card**

## Carina Nebula



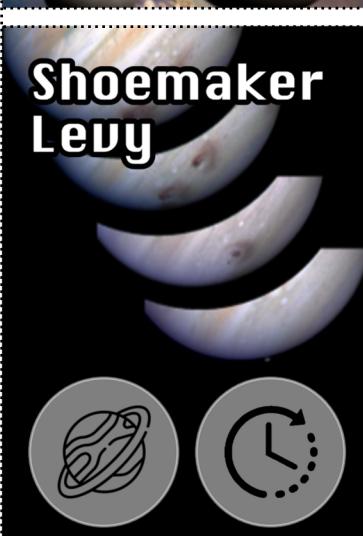
## Exoplanet Catalog



## Exoplanet WASP-39b



## Shoemaker Levy



## Bubble Nebula



## Cepheid Variable



## Alien Weather Report

### Ultraviolet Science Goal

Measure the composition of an exoplanet's atmosphere

4



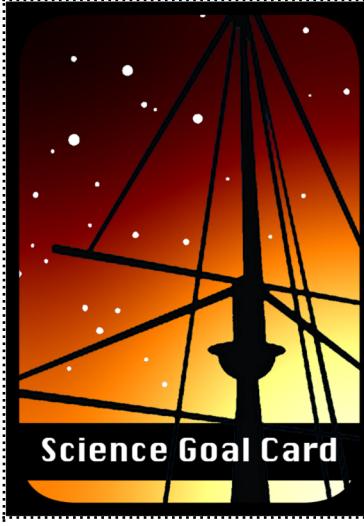
## Binary Stars

### Optical Science Goal

Study a binary star system with a star's spectrum and light curves

4





## Photometry

### Optical Science Goal

Take a lot of images!

6



## Optical Data Archive

### Optical Science Goal

Collect one of each data type to win 3 science points

3



## The Stars Are Born

### Infrared Science Goal

Observe ongoing star formation inside of four different nebula to research star formation

6



## Optical Sky Survey

### Optical Science Goal

Collect one of each object type to win 3 science points

3



## Source Catalogs

### Ultraviolet Science Goal

Make a lot of catalogs!

6



## Galactic Hotspots

### Ultraviolet Science Goal

Find Where Stars Are Forming In A Nearby Galaxy

4



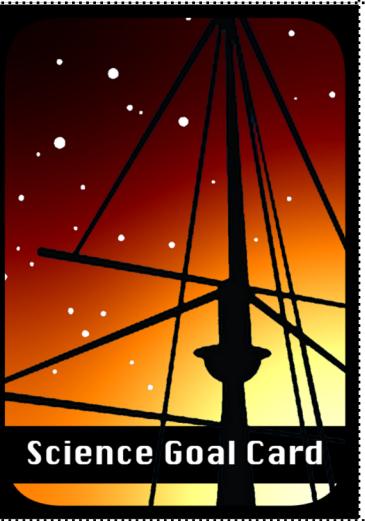
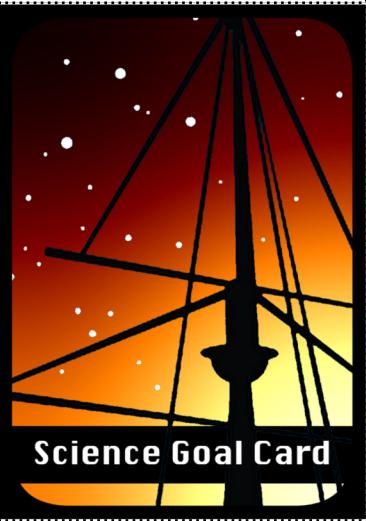
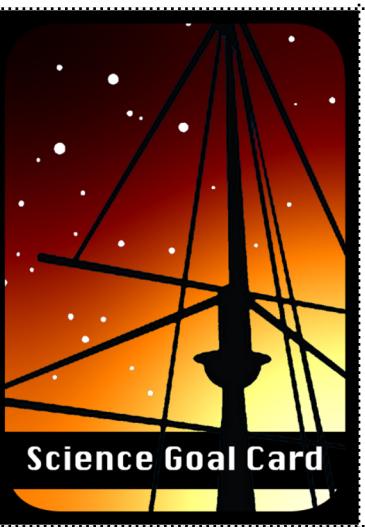
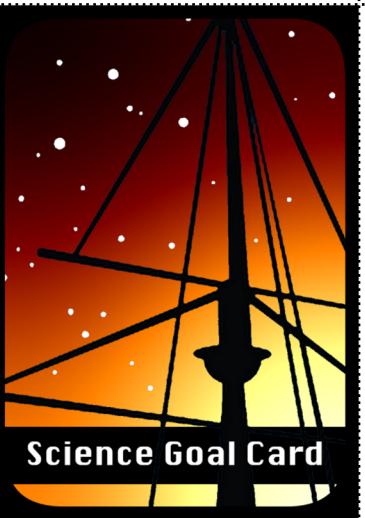
## Ultraviolet Data Archive

### Ultraviolet Science Goal

Collect one of each data type to win 3 science points

3





## Stellar Jets

### Ultraviolet Science Goal

Observe the jets thrown off by young stellar objects

5



## Spectroscopy

### Infrared Science Goal

Take a lot of spectra!

6



## Stellar Graveyard

### Optical Science Goal

Characterize different types of supernova by observing the remnants of dead stars in nebulae

5



## Ultraviolet Sky Survey

### Ultraviolet Science Goal

Collect one of each object type to win 3 science points

3



## Gravitational Lensing

### Infrared Science Goal

Use Gravitational Lenses To Study A Distant Galaxy's Properties

5



## Black Hole Indigestion

### Ultraviolet Science Goal

Monitor a tidal disruption event near the center of a galaxy

5



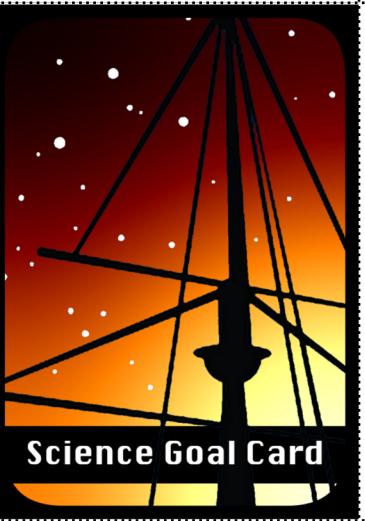
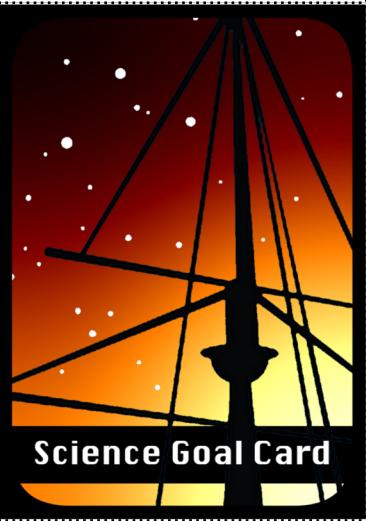
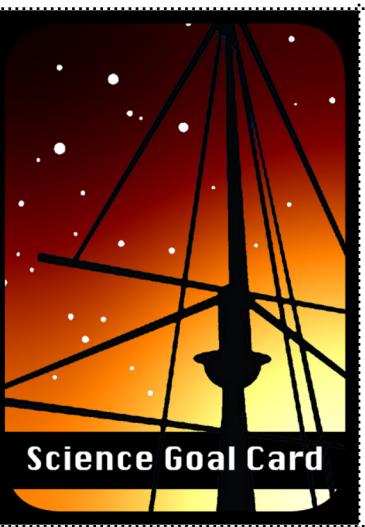
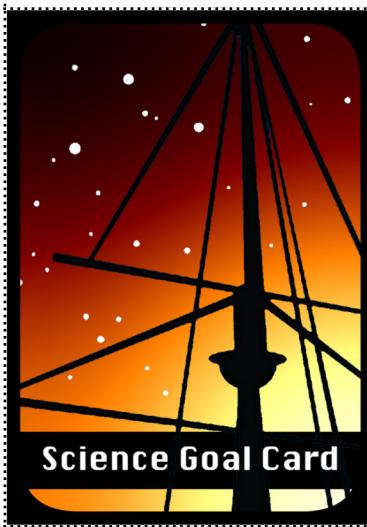
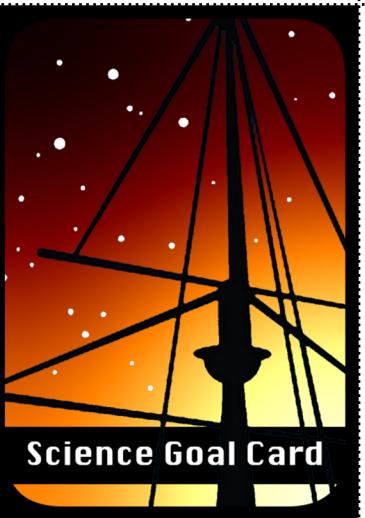
## Solar System

### Optical Science Goal

Observe four different planets to research how the Solar System was formed

6





## Galaxy Mergers

### Optical Science Goal

Study two galaxies that are merging together

5



## Eye of The Storm

### Ultraviolet Science Goal

Find out what's at the center of a planetary nebula

5



## Messier Catalog

### Optical Science Goal

Build a list of Messier objects by taking images and cataloging nebula

4



## The First Stars

### Optical Science Goal

Find the oldest stars in the galaxy to understand the history of the Milky Way

5



## High Redshift

### Infrared Science Goal

Observe four different galaxies to study the history of the Universe.

6



## Dust Maps

### Infrared Science Goal

Catalog different nebula to determine where the dust is in the Milky Way

5



## Cosmic Web

### Infrared Science Goal

Study the large scale structure of the Universe with catalogs of galaxies

5



## Infrared Sky Survey

### Infrared Science Goal

Collect one of each object type to win 3 science points

3



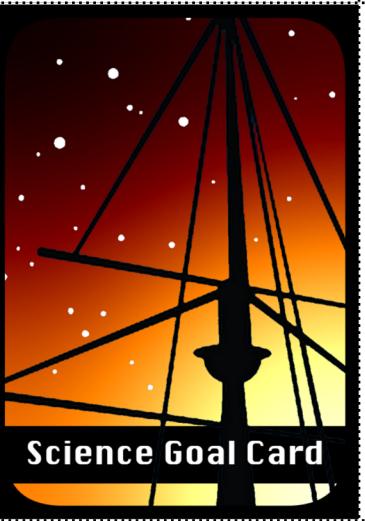
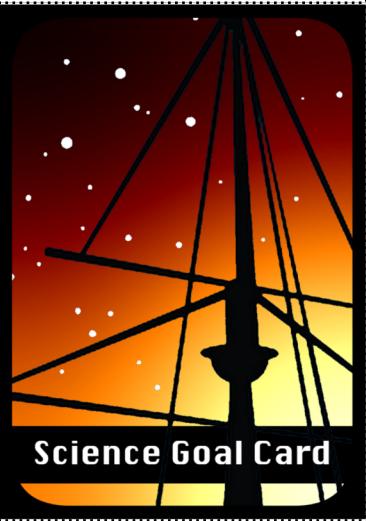
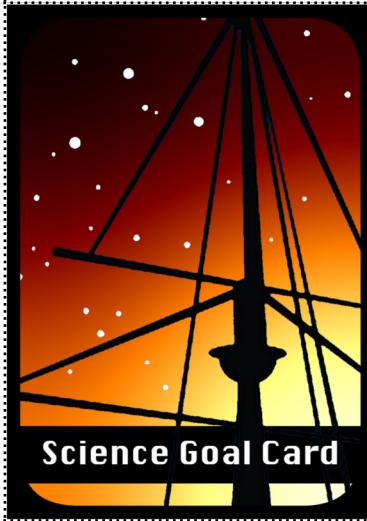
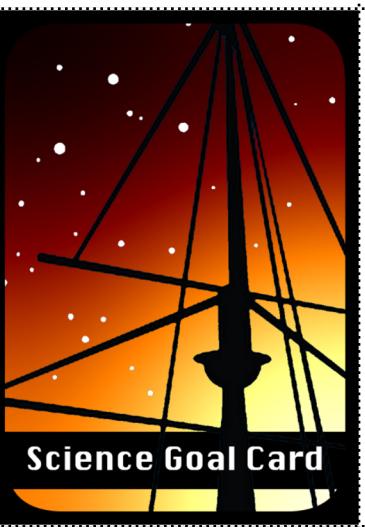
## Infrared Data Archive

### Infrared Science Goal

Collect one of each data type to win 3 science points

3





## Interstellar Dust

### Infrared Science Goal

Study the gas between galaxies by observing galaxies and nebula

4



## Drake Equation

### Optical Science Goal

Estimate The Number of Habitable Earth-like Planets In The Milky Way by cataloging planets

5



## The Dark Side

### Infrared Science Goal

Darkness here and nothing more. Study massive, cold dark nebulas.

5



## Build-a-Galaxy

### Ultraviolet Science Goal

Study the star formation history of a galaxy by determining what kinds of stars it is made of

4



## Brown Dwarfs

### Infrared Science Goal

Study star formation inside nebulae to characterize brown dwarfs - are they planets or stars?

4



## Mapping the Galaxy

### Infrared Science Goal

Map the Milky Way with large catalogs of stars

5



## Light Curves

### Optical Science Goal

Take a lot of light curves!

6



## Methane Clouds

### Infrared Science Goal

Cloudy with a chance of Methane! Study the chemical composition of clouds on other planets

5



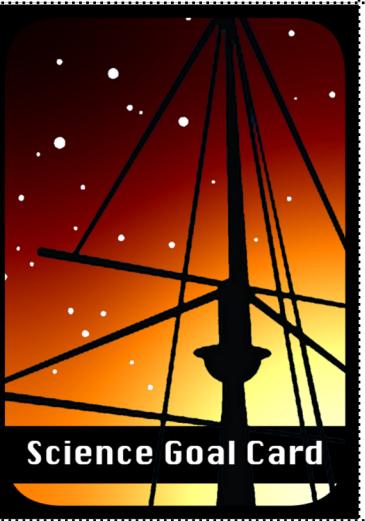
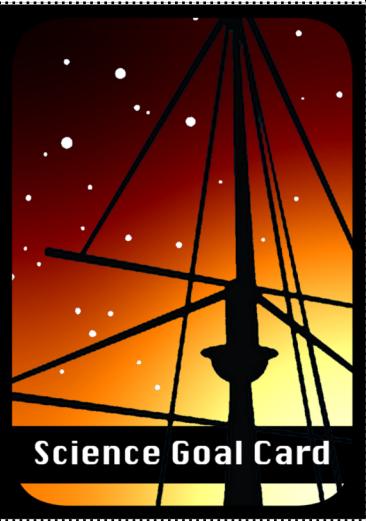
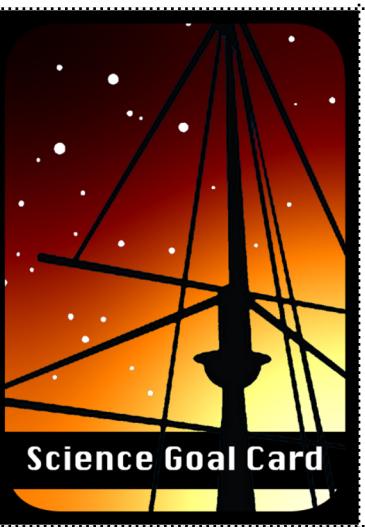
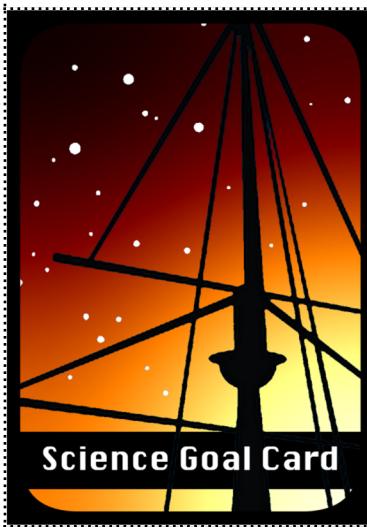
## Planet Formation

### Ultraviolet Science Goal

Study planet formation by observing planets in our solar system

5





## Deprecated Code

### Play Immediately

Choose one of your Science Goals and place this card next to it. You need one more card than usual to complete this Science Goal (for example, if you need 4 cards to complete the goal, you now need 5)

## Proposal Deadline

### Play Immediately

A big observing proposal is due this week! You skip your next turn. Keep this card in front of you as a reminder, and discard it at the end of your next turn.

## Micrometeoroid Strike

### Play Immediately

A telescope's mirror was just hit by a micrometeoroid! Place this card on top of one of the telescopes in the Telescope Row. No one can use this telescope until this card is discarded, which happens at the end of your next turn.

## New Discovery

### Play Immediately

You make a new discovery! The next observation card you collect can be added to any of your Science Goals, ignoring all requirements for object type, target type, or wavelength.

## Servicing Mission

### Play Later

Your telescope gets an upgrade! When you play this card during an Observing Action, you can pick two cards from the Observation Row instead of one.

## Follow-up Observation

### Play Later

Play this card when you take the Observation Action to play the Observation Card you collect on someone else's Science Goal. When you do, you earn 1 science point for helping them out.



## Long Exposure

### Play Later

When you play this card during an Observing Action, choose two observations from the Visible Sky row using the same telescope, and then skip your next turn.

## Not Enough Coffee

### Play Immediately

You do not have enough coffee to get your work done: skip your next turn. Keep this card in front of you as a reminder, and discard it at the end of your next turn.

## Conference Meeting

### Play Later

You present your results at a conference. Play this card on a Science Goal Card of your choice. That Science Goal is now worth 1 extra point.





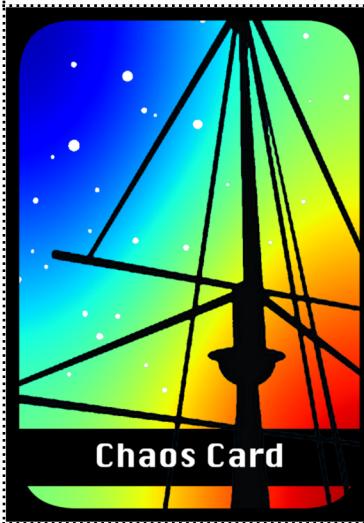
Chaos Card



Chaos Card



Chaos Card



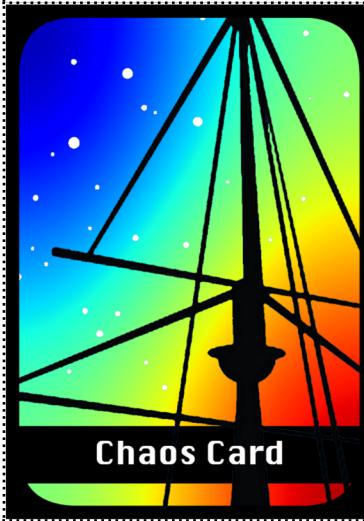
Chaos Card



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# Jupyter Notebook

## Play Immediately

Choose one of your Science Goals, and place this card on top. You need one less card than usual to complete this Science Goal. For example, if you need 4 cards to complete the goal, you now only need 3.

# Inspiration Strikes

## Play Immediately

You have a great idea for a new project! Draw a new Science Goal Card and place it face-up in front of you, adding it to your active Science Goals.

# Proposal Deadline

## Play Immediately

A big observing proposal is due this week! You skip your next turn. Keep this card in front of you as a reminder, and discard it at the end of your next turn.

# Target of Opportunity

## Play Immediately

This card is a wildcard. Treat this as any target type, data type, and wavelength, and immediately play it towards one of your Science Goals.



# Press Release

## Play Later

Host a press release to tell the world about your new result! When you complete your next Science Goal, reveal this card to immediately score an additional 2 points.

A large number 2 inside a light blue circle.

# Public Data

A large number 1 inside a light blue circle.

## Play Later

Choose any Observation Card that another player has on one of their Science Goals. Take that card from them, and play it on one of your own goals. In exchange, give them this card to replace the old observation, which still counts towards their Science Goal. They gain extra 1 science point for sharing their data!

# Corrupted Data

## Play Later

When another player tries to collect an Observation Card, play this card to immediately make them discard it. They do not get any points for that Observation Card, and must still return the Telescope they used to the Telescope Row.



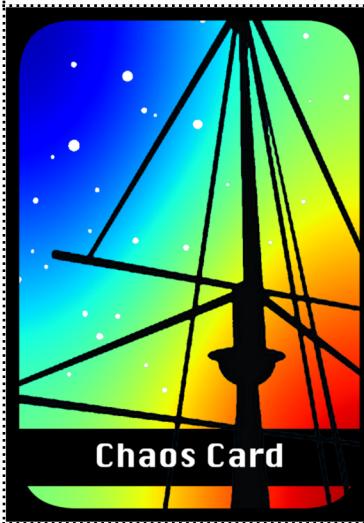
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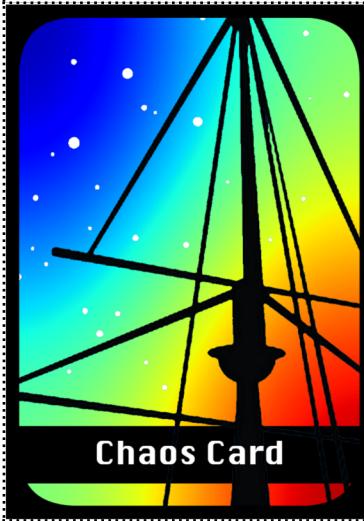
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## All-Nighter

Play Later

You decide to sacrifice sleep to get extra work done. Play this card at the beginning of one of your turns. You may take one additional action on your turn, for a total of two actions.

## Nobel Prize

Play Immediately

You win the Nobel Prize for your research. When you play this card, immediately score 5 points.



## Code Doesn't Compile

Play Later

Play this card on another player to make them skip their next turn. They can keep this card in front of them as a reminder, and discard it at the end of their next turn

## Cloud Computing

Play Later

Thanks to the power of cloud computing, you are able to complete your research more quickly. All of your Science Goals are now worth one additional point.



## Public Data



Play Later

Choose any Observation Card that another player has on one of their Science Goals. Take that card from them, and play it on one of your own goals. In exchange, give them this card to replace the old observation, which still counts towards their Science Goal. They gain extra 1 science point for sharing their data!

## Long Exposure

Play Later

When you play this card during an Observing Action, choose two observations from the Visible Sky row using the same telescope, and then skip your next turn.

## Too Much Coffee

Play Later

You have had too much coffee, and are feeling extremely productive but will crash later. Play this card at the beginning of one of your turns. You may take one additional action on your turn, for a total of two actions. Then skip your next turn.

## Dual Telescopes

Play Later

Play this card while Picking a Telescope; you may pick two telescopes instead of one during this turn, and use them both for observations on subsequent turns.



## Coauthor Request

Play Later

When another player completes a Science Goal, play this card to become a Coauthor on their paper and earn 1 extra science point for yourself.





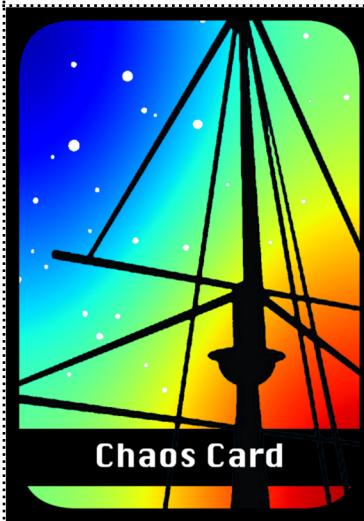
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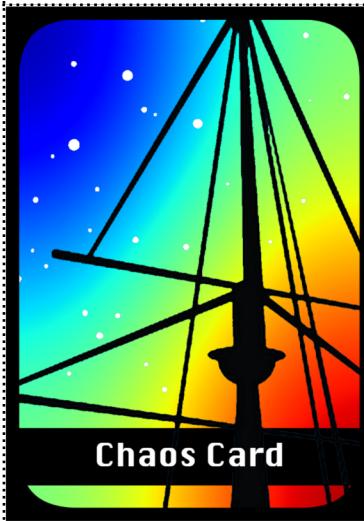
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Chaos Card

## Target of Opportunity

### Play Immediately

This card is a wildcard. Treat this as any target type, data type, and wavelength, and immediately play it towards one of your Science Goals.



## Proprietary Data

### Play Immediately

Look through the Observation Card draw pile and choose any card you would like. Play it towards any one of your Science Goals, but hide it underneath this card so the other players can't tell what it is. Re-shuffle the deck once you're done

## Grant Funding Ending

### Play Immediately

Your grant funding runs out, forcing you to start on a new project. Discard one Science Goal of your choice (and any observation cards linked to it), and draw a new Science Goal to replace it.

## Target of Opportunity

### Play Immediately

This card is a wildcard. Treat this as any target type, data type, and wavelength, and immediately play it towards one of your Science Goals.



## Open Source Collaboration

### Play Later

Trade one Science Goal Card with another player. All observation cards (and points) associated with that goal are also traded.

## Hire a Student

### Play Later

Hire a graduate student to get more work done! Look through the draw pile and choose any card you want. Add the selected card to one of your Science Goals (regardless of wavelength), and then discard this card and reshuffle the draw pile.

## Too Many Tabs Open

### Play Immediately

You have too many tabs open and can't find where you saved your data! Choose one observation card from any of your Science Goals, and return that card to the bottom of the draw pile.

## High Solar Winds

### Play Immediately

High radiation caused by solar winds causes your observation to be rescheduled; Discard all cards currently in the Visible Sky Row and replace them with new cards.

## Guiding Failure

### Play Immediately

The telescope failed to acquire guide star. If you have a telescope card currently in your hand, return it to the telescope row immediately without collecting an observation.



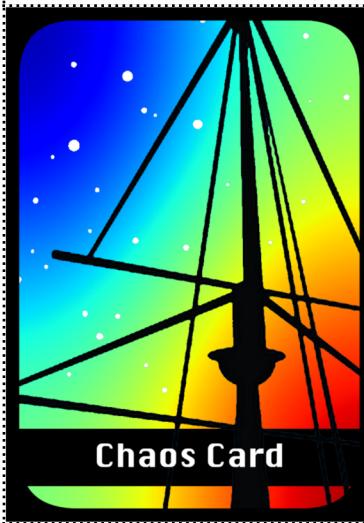
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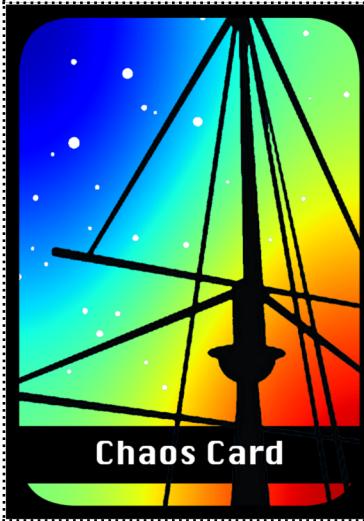
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## Target of Opportunity

### Play Immediately

This card is a wildcard. Treat this as any target type, data type, and wavelength, and immediately play it towards one of your Science Goals.



## Conference Meeting

### Play Later

You present your results at a conference. Play this card on a Science Goal Card of your choice. That Science Goal is now worth 1 extra point.



## Telescope Malfunction

### Play Later

When another player tries to collect an Observation Card, play this card to immediately make them discard it. They do not get any points for that Observation Card, and must still return the Telescope they used to the Telescope Row.

## Coauthor Request

### Play Later

When another player completes a Science Goal, play this card to become a Coauthor on their paper and earn 1 extra science point for yourself.



