Visualizing the Universe with NASA Data

Kimberly Kowal Arcand (SAO)
Dr. Robert Hurt (Caltech/IPAC)
Dr. Frank Summers (STScI)

Facilitator: Dr. Emma Marcucci (STScI)
Additional Resources

http://nasawavelength.org/list/2130

**Hands-on Activities:**
- ReColoring the Universe
- How to talk to a spacecraft
- 3D Printing the X-ray Universe
- Tinkercad: Universe in 3D

**Visualization Products and Process:**
- Walking Among the Stars
- Flight through the Orion Nebula
- Art of Astrophysics
- Eyes on Exoplanets

**Science Visualization Databases:**
- HubbleSite Science Videos
- AstroPix
- NASA Scientific Visualization Studio
Outline of this Science Briefing

1. Kimberly Arcand (SAO)
   Exploring Hidden and Exotic Worlds: How Astronomical Data Transports Us

2. Robert Hurt (Caltech/IPAC)
   Visualizing the Universe with NASA Data: The Art of Science Visualizations

3. Frank Summers (STScI)
   Cinematic Scientific Visualizations

4. Discussion / Questions
Delicate filamentary structure at \(10,000^\circ\)
<table>
<thead>
<tr>
<th>time (s)</th>
<th>x (pixels)</th>
<th>y (pixels)</th>
<th>Energy (eV)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.02 E + 08</td>
<td>3500.729</td>
<td>7173.726</td>
<td>309.2044</td>
</tr>
<tr>
<td>1.02 E + 08</td>
<td>3492.056</td>
<td>7197.004</td>
<td>618.6377</td>
</tr>
<tr>
<td>1.02 E + 08</td>
<td>3484.491</td>
<td>7168.971</td>
<td>371.0346</td>
</tr>
<tr>
<td>1.02 E + 08</td>
<td>3480.964</td>
<td>7167.965</td>
<td>472.1068</td>
</tr>
<tr>
<td>1.02 E + 08</td>
<td>3474.496</td>
<td>7165.451</td>
<td>404.8232</td>
</tr>
<tr>
<td>1.02 E + 08</td>
<td>3502.571</td>
<td>6911.464</td>
<td>10045.06</td>
</tr>
<tr>
<td>1.02 E + 08</td>
<td>3578.601</td>
<td>6607.331</td>
<td>572.6195</td>
</tr>
<tr>
<td>1.02 E + 08</td>
<td>3554.356</td>
<td>6450.474</td>
<td>11789.67</td>
</tr>
<tr>
<td>1.02 E + 08</td>
<td>3140.364</td>
<td>6648.117</td>
<td>4405.423</td>
</tr>
<tr>
<td>1.02 E + 08</td>
<td>3141.073</td>
<td>6645.747</td>
<td>4520.507</td>
</tr>
<tr>
<td>1.02 E + 08</td>
<td>3142.331</td>
<td>6642.593</td>
<td>2982.305</td>
</tr>
<tr>
<td>1.02 E + 08</td>
<td>3144.126</td>
<td>6636.678</td>
<td>2101.672</td>
</tr>
<tr>
<td>1.02 E + 08</td>
<td>3144.225</td>
<td>6634.338</td>
<td>1840.696</td>
</tr>
<tr>
<td>1.02 E + 08</td>
<td>3144.791</td>
<td>6632.823</td>
<td>1786.75</td>
</tr>
<tr>
<td>1.02 E + 08</td>
<td>3146.091</td>
<td>6630.315</td>
<td>1573.257</td>
</tr>
<tr>
<td>1.02 E + 08</td>
<td>3145.848</td>
<td>6628.534</td>
<td>1543.367</td>
</tr>
<tr>
<td>1.02 E + 08</td>
<td>3146.66</td>
<td>6626.825</td>
<td>1419.386</td>
</tr>
<tr>
<td>1.02 E + 08</td>
<td>3148.154</td>
<td>6621.553</td>
<td>1089.849</td>
</tr>
<tr>
<td>1.02 E + 08</td>
<td>2995.288</td>
<td>6841.834</td>
<td>889.9045</td>
</tr>
</tbody>
</table>
High Energy X-rays
Medium Energy X-rays
Low Energy X-rays
High Energy X-rays
Medium Energy X-rays
Low Energy X-rays
High Energy X-rays
Medium Energy X-rays
Low Energy X-rays
High Energy X-rays
Medium Energy X-rays
Low Energy X-rays
http://chandra.si.edu/photo/2009/casa2/
http://chandra.si.edu/3dprint
References:
http://chandra.si.edu/3dprint
http://chandra.si.edu/vr
http://astroart.cfa.harvard.edu
http://nasa3d.arc.nasa.gov

TEDx Talk:
http://youtube.com/watch?v=8kTMr5LqIBQ
The Art of Science Visualization
Can the data speak for itself?
BAD Words

False Color

Colorize

GOOD Words

Representative Color

Translated Color

Colors aren’t FALSE, only MISUNDERSTOOD
Contextual information from many astronomical data sources!
What if the data can not speak for itself?
Fig. 2.— SED of GD 16.
Collision event between large bodies in another star system produced increased dust emission
EXOPLANETS

What We See

What We Typically Measure

- Stellar type
- Orbital Period
- Orbital Distance
- Planet Size

(more rarely)
- Planet Mass
- Planet Density
- Atmosphere
Twice as big as Earth
Gaseous/Cloudy
Hot

Oceans imply habitable zone

Do NOT show greenery (NO evidence of life)

Star has color of incandescent light bulb

Large ice caps suggest cooler than Earth

3 inner planets
TRAPPIST-1
Figure 1 | The TRAPPIST-1 system as seen by Spitzer. (a) Spitzer photometric measurements (dark points) resulting from the nearly-continuous observation of the star from 19 September to 10 October 2016. The ground-based measurements (binned per 5 min for clarity) gathered during the Spitzer gaps are shown as light grey points. The position of the transits of the planets are shown as coloured diamonds. (b) Period-folded photometric measurements obtained by Spitzer near transits of planets TRAPPIST-1b-h corrected for the measured TTVs. Coloured dots show the unbinned measurements, whereas the open circle depict binned measurements for visual clarity. The best-fit transit models are shown as coloured lines. 16-11-5-2-3-2-1 transits were observed by Spitzer and combined to produce
Circling a Star Not Far Away, 7 Shots at Life

By KENNETH CHANG
Not just one, but seven Earth-size planets that may potentially harbor life have been identified orbiting a star that is not far from our own. This opens up a new opportunity to search for signs of alien life beyond the solar system.

REPRODUCIBILITY
PUT TO THE TEST
Add independent preclinical trials to biomedical papers
PAGE 405

CLIMATE SCIENCE
A MODEL FOR MELTING
Predicability of ice ages affirmed
PAGE 406, 427 & 428

Late Edition

TRUMP REJECTS OBAMA DIRECTIVE ON BATHROOM USE

ENTERING CULTURE WARS
Transgender Rights Split Devo's and Sessions

By ANNA M. HOLLAND, A. RIENER AND J. SCHLAGFELD
WASHINGTON — President Donald Trump on Wednesday rescinded government guidelines for transgender students that had allowed them to use bathrooms and locker rooms that aligned with their gender identity.

Migrants Hide, Fearing Capture on 'Any Corner'

By VINCE SIM
A police department massacre in Mexico has left 10 people dead, including two children, in an escalating crisis that is pushing many migrants to seek shelter in the United States.

IMMIGRATION A baseball stadium opens in the desert— a new home for a team of migrants who are seeking sanctuary from violence and persecution in their home countries.

By MELISSA YEE

Circling a Star Not Far Away, 7 Shots at Life

By KENNETH CHANG
Not just one, but seven Earth-size planets that may potentially harbor life have been identified orbiting a star that is not far from our own. This opens up a new opportunity to search for signs of alien life beyond the solar system.

Uber's Culture Of Gutsiness Under Review

By MIKE ISAAC
As a hockey player, Uber employees describe a culture that is driven by fear and aggression. The company's response to a recent crisis has been criticized by some as too soft.

Migrants Hide, Fearing Capture on 'Any Corner'

By VINCE SIM
A police department massacre in Mexico has left 10 people dead, including two children, in an escalating crisis that is pushing many migrants to seek shelter in the United States.

IMMIGRATION A baseball stadium opens in the desert—a new home for a team of migrants who are seeking sanctuary from violence and persecution in their home countries.

By MELISSA YEE

Circling a Star Not Far Away, 7 Shots at Life

By KENNETH CHANG
Not just one, but seven Earth-size planets that may potentially harbor life have been identified orbiting a star that is not far from our own. This opens up a new opportunity to search for signs of alien life beyond the solar system.

Uber's Culture Of Gutsiness Under Review

By MIKE ISAAC
As a hockey player, Uber employees describe a culture that is driven by fear and aggression. The company's response to a recent crisis has been criticized by some as too soft.

Migrants Hide, Fearing Capture on 'Any Corner'

By VINCE SIM
A police department massacre in Mexico has left 10 people dead, including two children, in an escalating crisis that is pushing many migrants to seek shelter in the United States.

IMMIGRATION A baseball stadium opens in the desert—a new home for a team of migrants who are seeking sanctuary from violence and persecution in their home countries.

By MELISSA YEE

Circling a Star Not Far Away, 7 Shots at Life

By KENNETH CHANG
Not just one, but seven Earth-size planets that may potentially harbor life have been identified orbiting a star that is not far from our own. This opens up a new opportunity to search for signs of alien life beyond the solar system.

Uber's Culture Of Gutsiness Under Review

By MIKE ISAAC
As a hockey player, Uber employees describe a culture that is driven by fear and aggression. The company's response to a recent crisis has been criticized by some as too soft.

Migrants Hide, Fearing Capture on 'Any Corner'

By VINCE SIM
A police department massacre in Mexico has left 10 people dead, including two children, in an escalating crisis that is pushing many migrants to seek shelter in the United States.

IMMIGRATION A baseball stadium opens in the desert—a new home for a team of migrants who are seeking sanctuary from violence and persecution in their home countries.

By MELISSA YEE
Many Other Resources:

spitzer.caltech.edu/trappist-1
FUN
Sometimes scientists...

...play with their data!
Parting STEAM thought:

Science-motivated art is a game ANYONE CAN PLAY!

Encourage everyone from kids to adults to learn all they can… …and then make it art!
Cinematic Scientific Visualizations

Dr. Frank Summers
Space Telescope Science Institute
Data

Hubble: Galaxies Across Space and Time

Best Short Film 2004
Large Format Cinema Association
Modeling
Camera
Camera tracks in x, y and z
Dots are keyframe positions

Control tangents in/out of keyframes
for smoothest camera motion
Rendering

Cosmic Pointillism
Pointillism

• Point-based rendering code
  – Written in C, only one dependency (libtiff)
  – Point types: stars, clouds, [billboards, lines, etc.]
    • Circular splats with color and opacity profiles
      – Boxcar, trapezoid, linear, exponential, Gaussian, and other
    • Emissive and absorptive properties
    • All intermingled in 3D
  – Includes virtual cameras: perspective, dome, all-sky
Render Farm
Music
Message
ASTC partnership

A Professional Development opportunity – How to Use NASA Resources; future funding resources available

- Seven webinars to be held in 2018, with these goals:
  - *Increase knowledge of NASA Astrophysics-related concepts*
  - *Improve familiarity of NASA Astrophysics resources and ways to use them*
  - *Utilize real NASA data*
  - *Interact with NASA Subject Matter Experts*

- To participate, join NASA’s Universe of Learning Community of Practice (CoP) through ASTC: [http://community.astc.org/home](http://community.astc.org/home).

- Webinars will be archived for later viewing, including this introductory video: [https://vimeo.com/252961419](https://vimeo.com/252961419)

As a follow-on to this webinar series, there will be an opportunity to apply for **$2,500** mini-fund resources to be competitively awarded to selected institutions, in order to implement or facilitate programming, produce exhibits, etc., using Universe of Learning resources.
To ensure we meet the needs of the education community (you!), NASA’s UoL is committed to performing regular evaluations, to determine the effectiveness of Professional Learning opportunities like the Science Briefings.

If you prefer not to participate in the evaluation process, you can opt out by contacting Kay Ferrari <kay.a.ferrari@jpl.nasa.gov>.

This product is based upon work supported by NASA under award number NNX16AC65A to the Space Telescope Science Institute, working in partnership with Caltech/IPAC, Jet Propulsion Laboratory, Smithsonian Astrophysical Observatory, and Sonoma State University.

Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Aeronautics and Space Administration.