BIG STORIES
in
Planetary Science
and Heliophysics

Lou Mayo
NASA Goddard Space Flight Center
February 15, 2019
RIP Opportunity

Spirit and Opportunity
BY THE NUMBERS

6 YEARS lifespan
124,838 raw images
4.8 MILES traveled
30 DEGREES steepest slope

14+ YEARS lifespan
217,594 raw images
28 MILES traveled
32 DEGREES steepest slope

Updated February 4, 2019
We’ve Come So Far

1600’s  Community acceptance of a sun centered “universe”.

1761  1st accurate distance to the sun, computed – Jerome Lalende

1838  1st accurate distance to nearby star (61 Cygni) measured – Friedrich Bessel

1800’s  The sun shines by infalling planetesimals!!

1939  The sun shines by fusion reaction (proton-proton reaction) – Hans Bethe

1908  “Mars: As the Abode of Life” - Percival Lowell

1965  Mars is a dead – 1st successful Mars flyby (Mariner 4)

1859  Solar Wind 1st theorized – Richard Carrington

1959  1st direct observation of the solar wind – Soviet Luna 1

1973/79  Pioneers 10 and 11 flyby Jupiter and Saturn

1977  Voyagers 1 and 2 launched

2015  New Horizons Pluto Flyby

2018  New Horizons MU69 Flyby
Big Questions

PLANETARY SCIENCE
How did the SS form?
How will the SS evolve?
Are we alone?

HELIOPHYSICS
What drives changes in the sun?
What drives solar storms and the solar wind?
How does the sun impact humanity and the solar system?
Mars / Maven
Curiosity Discovers Seasonal Cycle in Mars Methane

<table>
<thead>
<tr>
<th>Spring</th>
<th>Summer</th>
<th>Autumn</th>
<th>Winter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mars Year 32</td>
<td>Mars Year 33</td>
<td>Mars Year 34</td>
<td></td>
</tr>
</tbody>
</table>

CH$_4$ parts-per-billion

Surface Uptake

Surface Release

Abiotic Production or Microbial Production

Fissures

Cracks

Faults

Subsurface reservoirs of methane created from water-rock chemistry and/or from microbial activity. These include methane trapped in clathrates or magmatic chambers.

NASA/JPL-Caltech
Bennu / OSIRIS REx
Saturn / Cassini
Pluto, MU69 / NEW HORIZONS

NASA SPACE SCIENCE EXPLORATION
Heliopause / Voyagers I, II
What's Next??

NEW FRONTIERS PROGRAM
Europa / Europa Clipper
Comet 67P C-G / CAESAR
Titan / Dragonfly
Animation of Dragonfly in flight over Titan

http://dragonfly.jhuapl.edu/Gallery/#Gallery