

## Space Exploration: The Rosetta Mission

Ian Wright, Professor of Planetary Sciences



RAL Space 10<sup>th</sup> Appleton Space Conference Rutherford Appleton Laboratory R22 Lecture Theatre Thursday 4<sup>th</sup> December 2014



IOP Institute of Physics Juno Practitioner







## Rosetta Launch Event



Credit : PPARC Frontiers Spring 2004











European Space Agency

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Credit: ESA/Rosetta/MPS for OSIRIS Team MPS/UPD/LAM/IAA/SSO/INTA/UPM/DASP/IDA



Credit: ESA/Rosetta/MPS for OSIRIS Team MPS/UPD/LAM/IAA/SSO/INTA/UPM/DASP/IDA







## Comet Holmes







Comet Lovejoy





## Earth

## Tail extends for ~150 slides





4100 m

Map data ©2014 Google, Bluesky Google

European Space Agency

Tower of London

·eesa

www.esa.int

The Small Questions:

How big is it? Shape? Rotation? Orbital Characteristics? Color? What's it made of? Magnetic Properties? Porosity? Temperature? What's it like inside? Electrical Properties? How does it change as it heads towards the Sun? Dust? Ice? What is its strength?

The BIG Questions:

How is it related to the other bodies of the Solar System?

What can we learn about our home planet by observing it up close?

And, what can we learn about us as sentient, conscious beings?

The BIG Answers:

Because it is a surviving remnant from the events that happened about 4.5 billion years ago, when the Sun and planets formed.

It is an opportunity to gaze at our ancestral, abiological beginnings and to search for clues as to how such materials begat life.



"a state of being alive"

"a state of being alive"

"the sum of activities of plants and animals"

"a state of being alive"

"the sum of activities of plants and animals"

"the period between birth and death"

# "Living organisms are defined as those that have the attributes of reproduction, growth and metabolism"

2.1.2, respectively Sections 2.2-2.5 then consider in a requirements for life, which you will turn each of questions 1 to 4. 2.1.1 First life: the universal ancestor It is not easy to define life. Scientists (and philosophers and theologians) have struggled with a satisfactory meaning for years. Dictionary definitions include being alive 'the second s illuminating or useful in this context. How were living organisms defined in Chapter 2 of Book 5? Living organisms were defined as those that had the attributes of The antibutes of me discussed in Book 5 in oe expanded stantly here to describe living organizes as those that have three interconnected systems: a system for the transmission of information (inheritance or heredity); a system for extraction and processing of energy (metabolism) and a system to isolate the entity from its surroundings and to contain its essential components (a membrane). Table 2.1 gives some characteristics of living organisms.



## **No Life**

Life









### rosetta

### → RENDEZVOUS WITH A COMET A KEY TO THE ORIGINS OF THE SOLAR SYSTEM

esa

### 20 January 2014

Rosetta wake up. Exit deep-space hibernation

#### May 2014

Deep-space rendezvous manœuvres

July 2014 Start of close comet observation

### August 2014

Rendezvous with Comet 67P/Churyumov-Gerasimenko

### September 2014

Start of close surface mapping

### November 2014

Lander will arrive on the surface of the comet

### End 2014

Monitoring of the comet's activity and evolution from close quarters

### August 2015

Closest approach to the Sun












Rosetta's Philae lander includes a carefully selected set of instruments and is being prepared for a November 11th dispatch to analyze a comet's surface. (Credit: ESA, Composite – T.Reyes)

# 67P/Churyumov-Gerasimenko









Slopes



Comet set: CG\_Model\_ESA\_003\_1 Shape: CSHP\_DV\_025\_01\_\_\_\_\_00039.ROS Kin: CATT\_DV\_025\_01\_\_\_\_\_00039.ROS Shape credits: ESA ©2014



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### → PHILAE'S LANDING SITE







# → PHILAE'S LANDING SITE











Credit: ESA/Rosetta/MPS for OSIRIS Team MPS/UPD/LAM/IAA/SSO/INTA/UPM/DASP/IDA







World UK England N. Ireland Scotland Wales Business Politics Health Home



**Rosetta comet landing: Professor's excitement and tears** 

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Rosetta comet landing: Professor's excitement and tears M VIC Bre





Credit: ESA/Rosetta/MPS for OSIRIS Team MPS/UPD/LAM/IAA/SSO/INTA/UPM/DASP/IDA





The location of the first landing site, "Agilkia," and possible location of where the lander ended up, 1 kilometer away. ESA/EDIT BY IAN O'NEILL

# → CONSERT estimation of landing area















### http://mattias.malmer.nu














http://mattias.malmer.nu

15<sup>th</sup> April (~5,000,000 km) Post-Hibernation Commissioning

13<sup>th</sup> July (15,000 km) Pre-Delivery Cometary Science

14th July (15,000 km) Pre-Delivery Cometary Science

15<sup>th</sup> September (30 km) Pre-Delivery Cometary Science

16<sup>th</sup> September (30 km) Pre-Delivery Cometary Science

6<sup>th</sup> October (20 km) Pre-Delivery Cometary Science 7<sup>th</sup> October (20 km) Pre-Delivery Cometary Science

16<sup>th</sup> October (10 km) Pre-Delivery Cometary Science

17<sup>th</sup> October (10 km) Pre-Delivery Cometary Science







Date and Time (UTC)	Ptolemy measurement	Results	Comments
12 – Nov 15:43:46	MS sniff (13 minutes)	6 Mass spectra	9 minutes after landing. Water and rich in organics
13 – Nov 06:35:15	MS sniff (10 minutes)	6 Mass spectra	comet day. Mainly water, very low organics
13 – Nov 08:37:18	MS sniff (10 minutes)	6 Mass spectra	comet dusk. Philae in shadow
13 – Nov 10:39:20	MS sniff (10 minutes)	6 Mass spectra	comet night
13 – Nov 12:41:21	MS sniff (10 minutes)	6 Mass spectra	comet night.
14 – Nov 02:54:36	MS sniff (2 minutes)	6 Mass spectra	comet late night
14 – Nov 12:36:52	MS sniff (2 minutes)	6 Mass spectra	comet early night. Mainly water, very low organics
14 – Nov 22:38:19	HTO/CASE (40 minutes)	275 Mass spectra	Attempt to analyse material collected in CASE oven during landing and any concentrated coma.



**Bin number** 

500



















# THE LANCET

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Letters to the Editor

### UNIDENTIFIED CURVED BACILLI ON GASTRIC EPITHELIUM IN ACTIVE CHRONIC GASTRITIS

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#### STFC-funded involvement with ESA Rosetta Mission



- Portfolio of technologies based on GC-MS
- Multi-disciplinary team of scientists, analysts, engineers and classification software programmers allows development of affordable, robust, deployable, application specific solutions for use by non-experts
- Partnering with end-users and experts to develop new application areas

## *Beagle 2*, PhD studentships, Wellcome Trust Strategic Translation Award, Contract Research







Wellcome Trust Strategic Translation Award to develop a mass spectrometer capable of rapidly detecting TB in resource-poor countries THM-GC-MS - initially TBSA investigated, good in culture – poor in sputum

- PDIM Assay patent filed June 2011 (not continued) and trial results published in PLOS One in 2012
- Blinded test (395 sputum samples) sensitivity of 64.9% and specificity of 76.2%
- Bespoke Optic 3 PTV injector, GC Module, Ion Trap MS and classification algorithm. Onboard PC & vacuum pumps
- Touch screen control with user configured software interface
- Commercial qMS now integrated for SIM



Can dogs smell bladder cancer?

Better than expected by chance P712

329:693-750 No 7468 25 SEPTEMBER 2004 Clinical research ISSN 0959-8138



### A step change in a vital piece of safety equipment on board future Royal Navy Submarines



The equipment has been tested on patrol, and has demonstrated a significant improvement over the existing equipment



(Absent: Bill Guthery, Max Bardwell, Brijen Hathi)







**Meteorite Analysis** 

SERC, PPARC, STFC, ESA, UKSA



Ptolemy on Rosetta

Wellcome Trust Strategic Translation Award



Field Deployable System



Linking Analytical Sciences with Instrument Development & Pest Control Expertise





