

$$4) \quad 3 \times 9 = ?$$

$$= 3 \times \sqrt{81} = 3\sqrt{81} = 3\sqrt{\frac{27}{6}} = 27$$
$$\frac{6}{21}$$
$$\frac{21}{0}$$

"Handy exam trick: when you know the answer but not the correct derivation, derive blindly forward from the givens and backward from the answer, and join the chains once the equations start looking similar. Sometimes the graders don't notice the seam." -XKCD

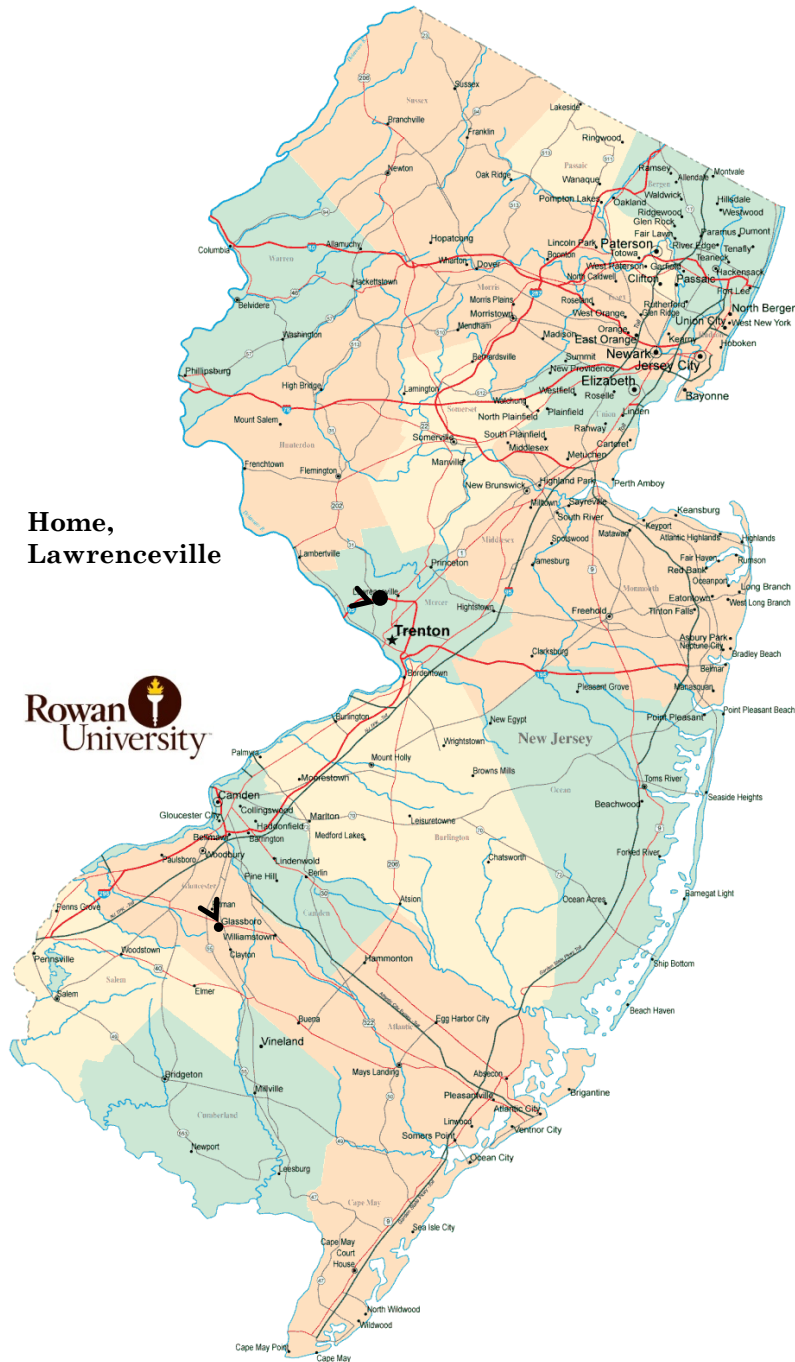
ALWAYS START WITH A JOKE

CLUSTERING OF MARS PLANETARY DATA

by Carl Campbell



**Department of Physics &
Astronomy**



Home,
Lawrenceville



○ Education

- Senior at Rowan University
- Computer Science & Physics
- Research
 - 2 years planetary science & physics w/ Dr. David Klassen

○ Internship

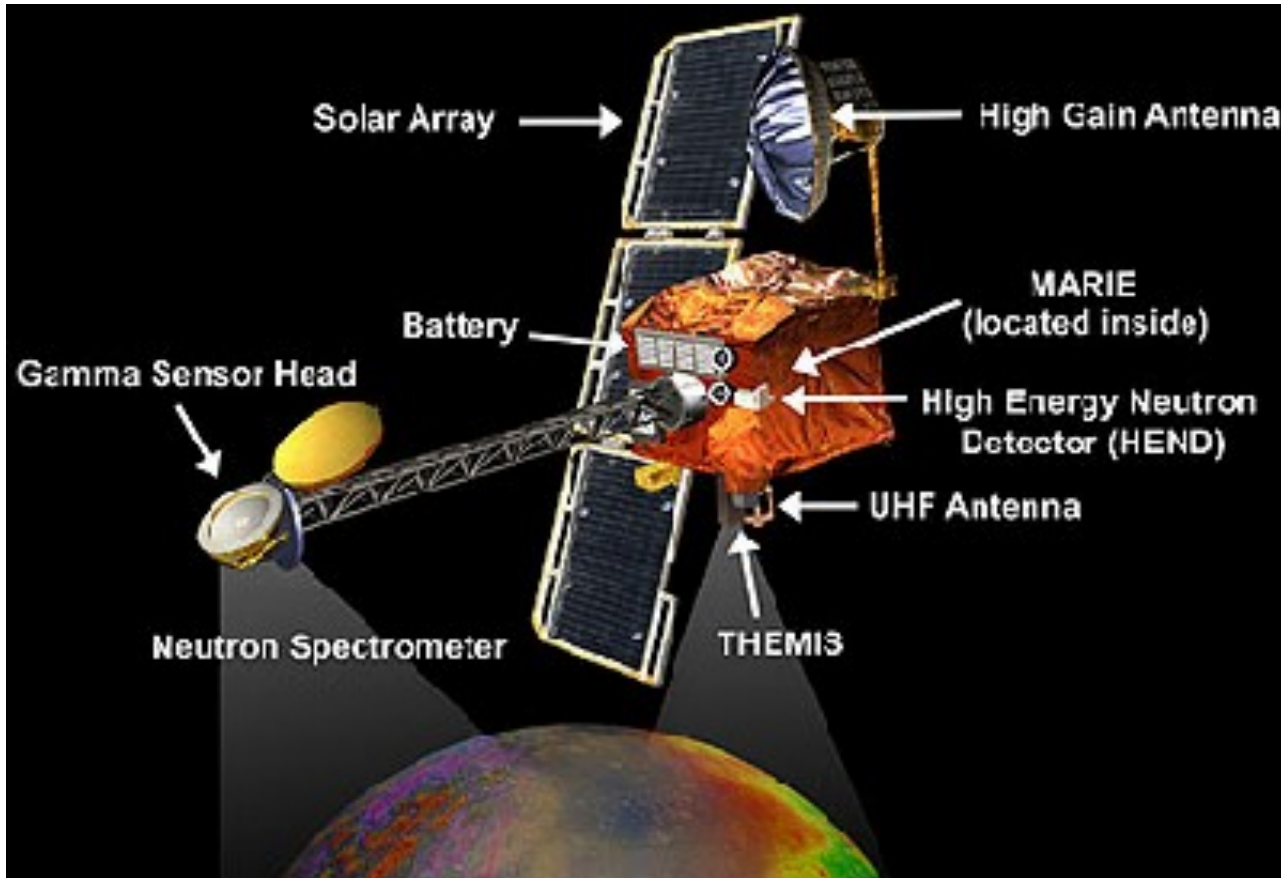
- NASA-LEND-SPS scholars program
- Continuation of past research

○ Career Interests

- Software design/programming
- Visualization
- Research: planetary science, planetary science, nuclear physics

ABOUT ME

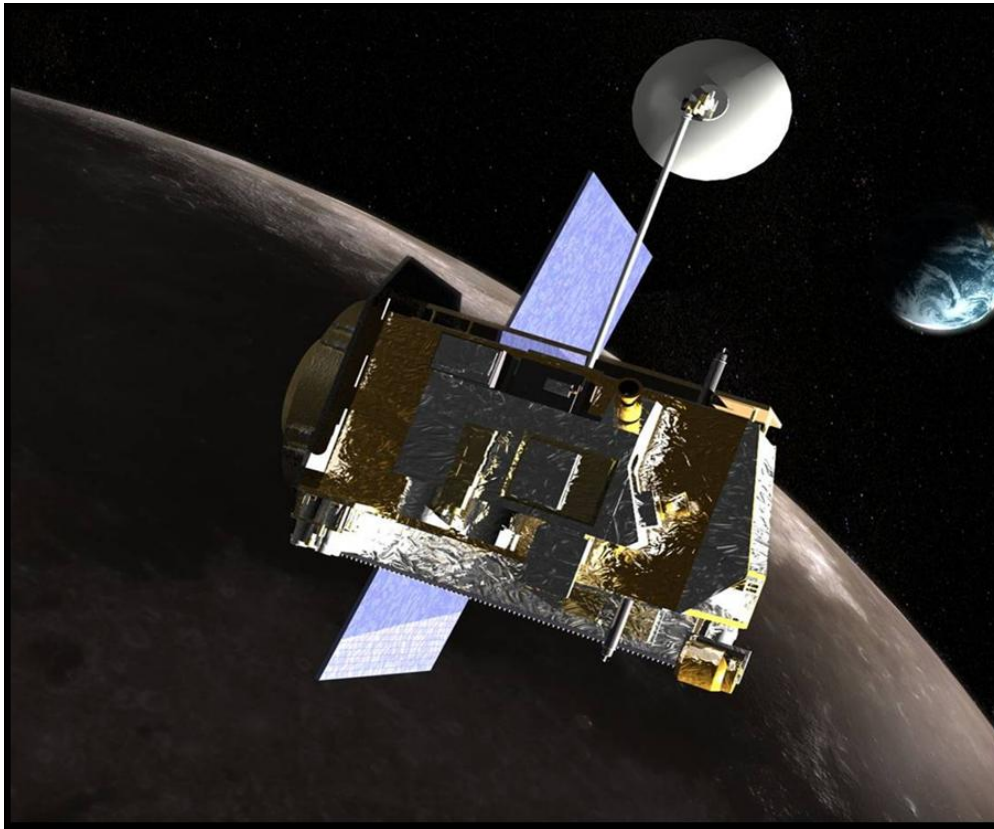




Mars Odyssey

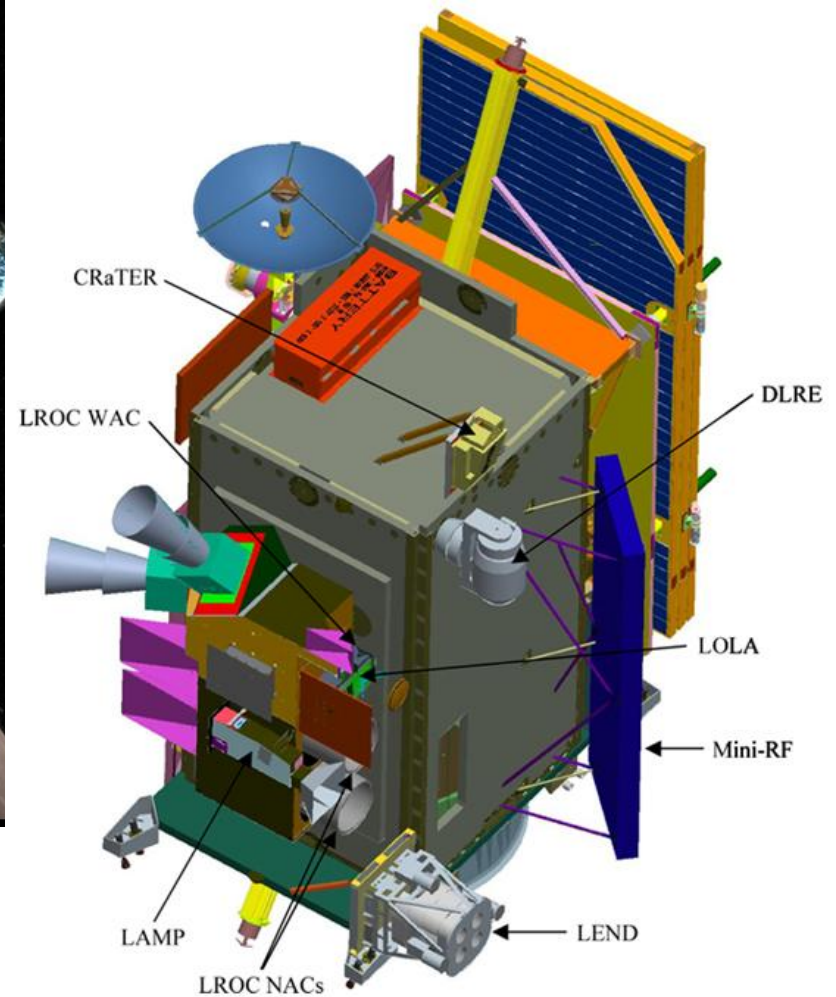
- 2001
- Key instruments: High Energy Neutron Detector (HEND) [Russians] and Gamma Ray Spectrometer (GRS)

RESEARCH
BACKGROUND



Lunar Reconnaissance Orbiter

- 2009
- Key instrument: Lunar Exploration Neutron Detector (LEND), again Russians



BACKGROUND



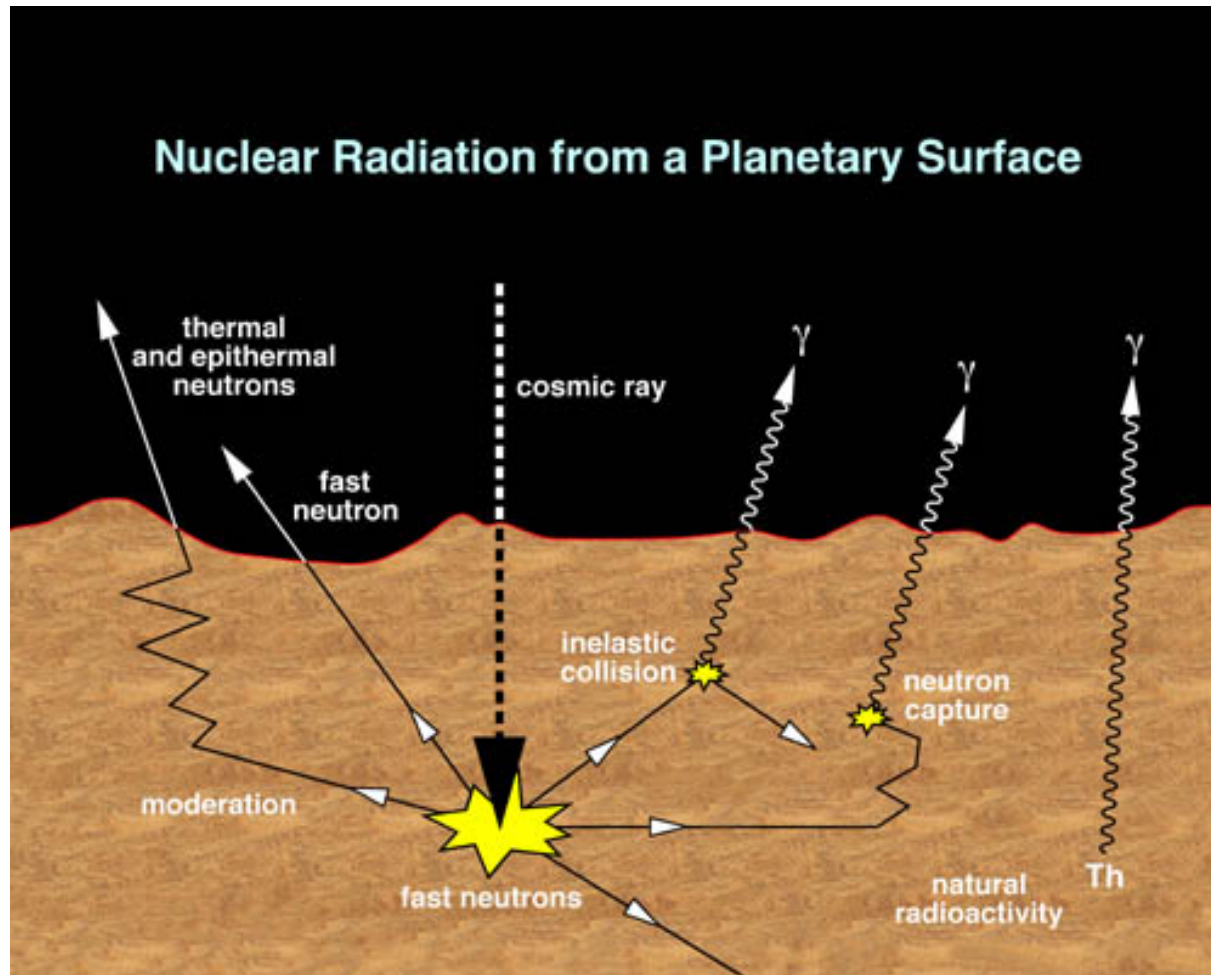
CHEAT SHEET!

- Odyssey → Mars
 - L.R.O. = **Lunar Reconnaissance Orbiter** → Moon
 - Prospector → Moon (1998)
 - G.R.S. = **Gamma Ray Spectrometer** → Odyssey
 - H.E.N.D. = **High Energy Neutron Detector** → Odyssey
 - L.E.N.D. = **Lunar Exploration Neutron Detector** → LRO
 - Notice LRO has NO Gamma Ray sensitive device listed here?
- **You will be quizzed in 3 seconds...**

REMEMBER THESE



- OK no quiz! But...
- A bit on Neutron/Gamma Ray Spectroscopy

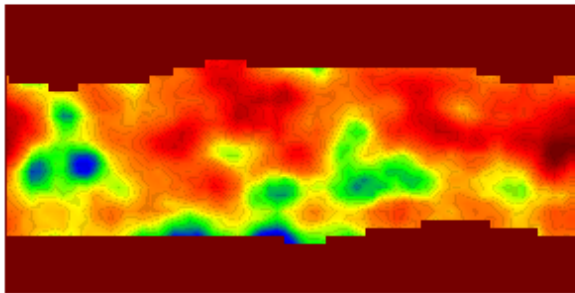


THE QUIZ IS A LIE



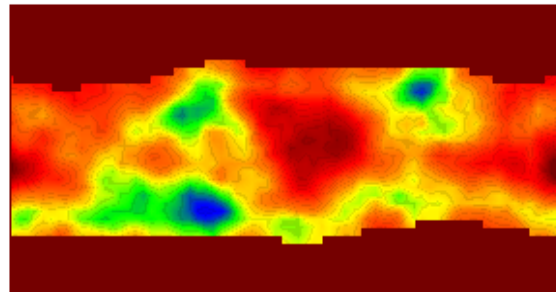
GAMMA RAY SPECTROSCOPY != NEUTRON

SPECTROSCOPY GRS

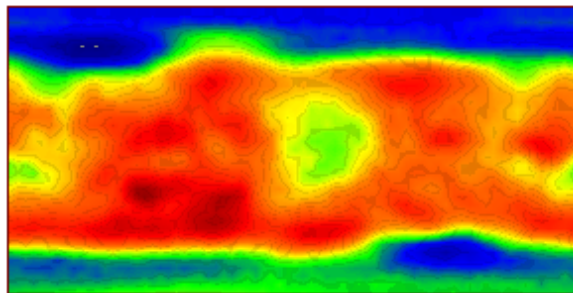


Iron

Hydrogen



HEND



Epithermal Flux

Direct elemental
abundance



Discrete groups of
neutron counts

RESEARCH ●
MOTIVATION

```
Carl: clustCompareAPP.pro - Kate
File Edit Document View Bookmarks Tools Sessions Settings Window Help

clustCompareAPP.pro
name_string = "clustCompareAPP"
END
;this should be rewritten with a file system that reads the available folders rather than hard coding the planets/orbiters. The code
;ends up very similar.
PROC clustCompareAPP
  widget_control, ev.top, get_uvalue=info
  CASE uvalue OF
    "PROSPECTOR" BEGIN
      children = widget_info(*info).orbiterDisplay, /ALL_CHILDREN
      FOR j=0, n_elements(children)-1 DO BEGIN
        widget_control, children[j], /DESTROY
      ENDFOR
      ;set up lunar orbiter buttons
      prospectorBtn = widget_button(*info).orbiterDisplay, uvalue = "prospector", value = "Prospector")
      lroBtn = widget_button(*info).orbiterDisplay, uvalue = "lro", value = "LRO")
      availableFiles = ptr_new[prospectorFiles:strarr(50), lroFiles:strarr(50)]
      (*info).planetSelection = "moon"
      ;parent = temporary(widget_info(*info).fileContainer, /PARENT)
      ;widget_control, (*info).fileContainer, /DESTROY
      ;display the current selected moon data
      (*info).planetSelection = "moon"
    END
  END
  IF(*info).planetSelection NE "mars") THEN BEGIN
    children = widget_info(*info).orbiterDisplay, /ALL_CHILDREN
  END
END

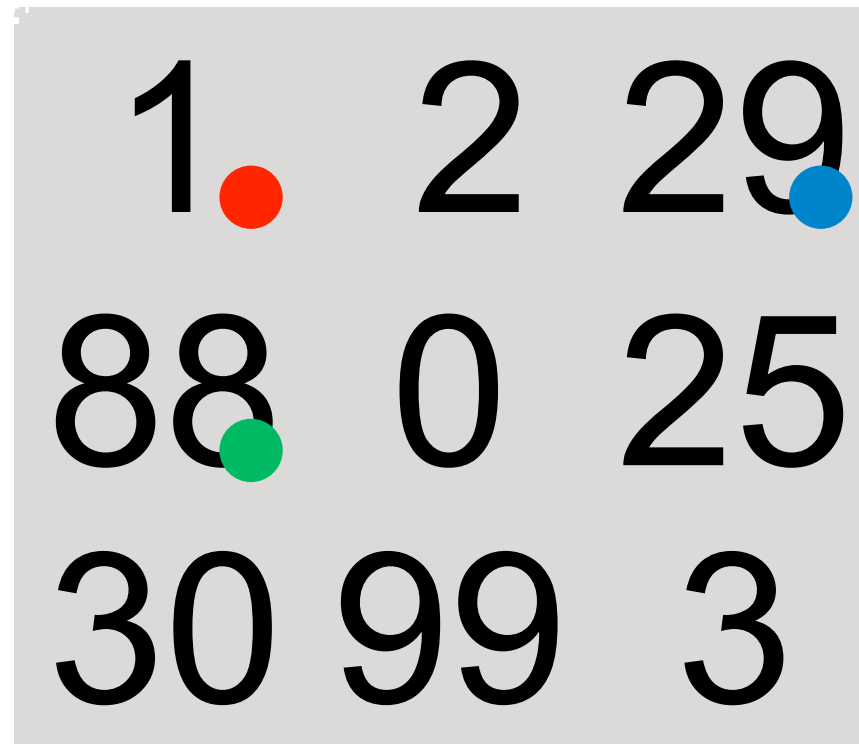
Line: 29 Col: 105   INS  NORM  clustCompareAPP.pro

[example@root ~]$ cd /usr/local-remote/klassen/lenz/student-Carl/
[example@root student-Carl]$ idl
IDL Version 7.1.1 (linux x86_64 m64) (c) 2009, ITT Visual Information Solutions
Installation number: 231144-I
Licensed for use by: Rowan College
```

- Program I wrote in IDL uses clustering as a means to analyze the data
- Groups data into “most similar” partitions
- Works in 2D and 3D (single set/multiple sets)
- Aids outlining patterns in data

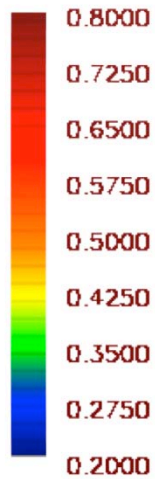
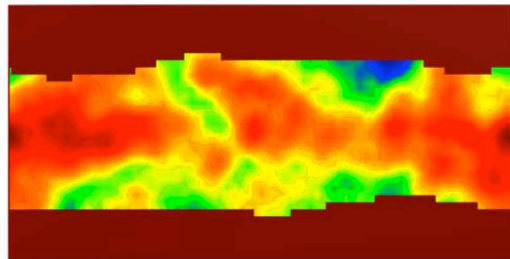
HOW? CLUSTERING. THAT'S HOW.

- Let's look at a small map of some surface given by a neutron detector
- For simplification purposes we'll fill it with some arbitrary numbers
- `int N = 3;`
- The program will pick random locations to start the "partitions" or clusters however they can be weighted if chosen
- Now it can begin to organize the data piece by piece into the groups
- All the data has now been grouped for similarity, though not all are adjacent
- One set == 2D. Including more sets of data pushes into the 3rd dimension, and these partitions can be thought of as volumes

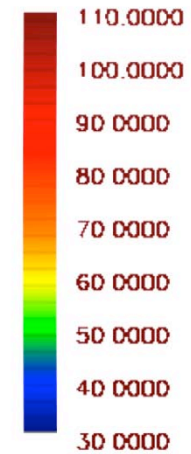
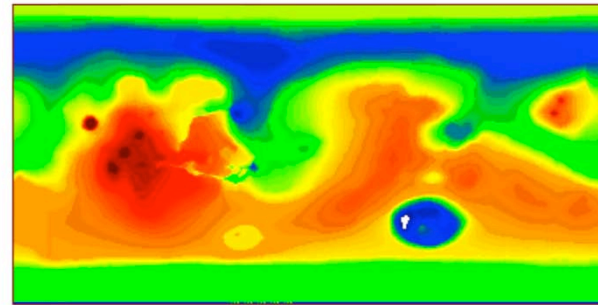


“CLUSTERING FOR DUMMIES”

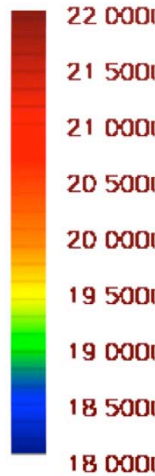
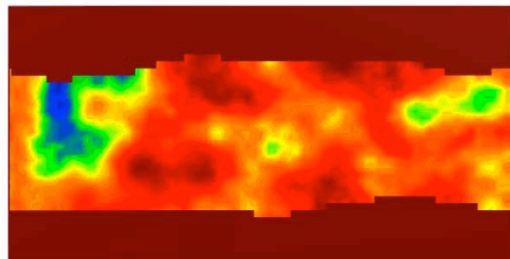
Chlorine
(GRS)



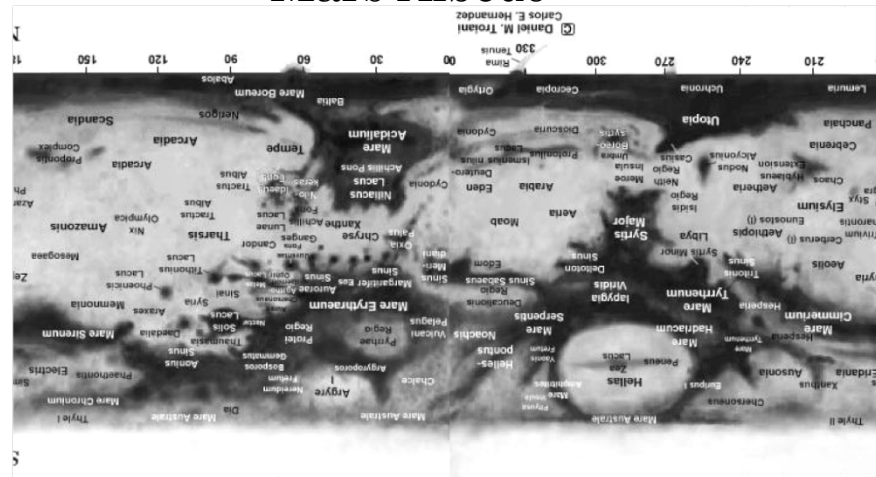
Mars Topo Map



Silicon
(GRS)



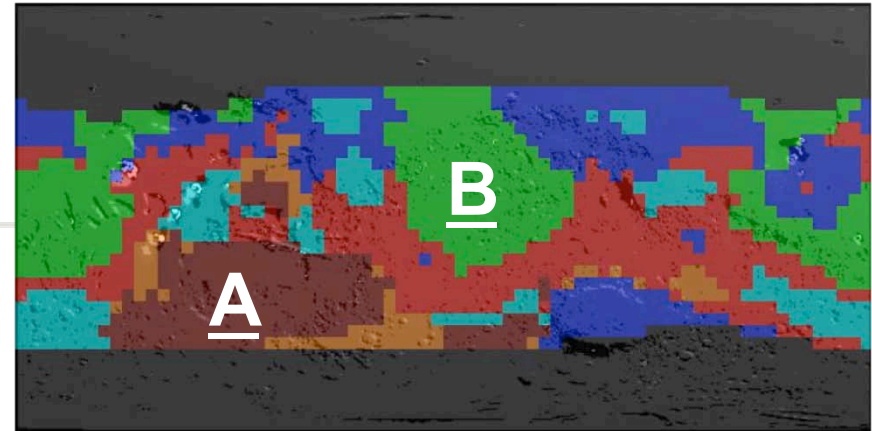
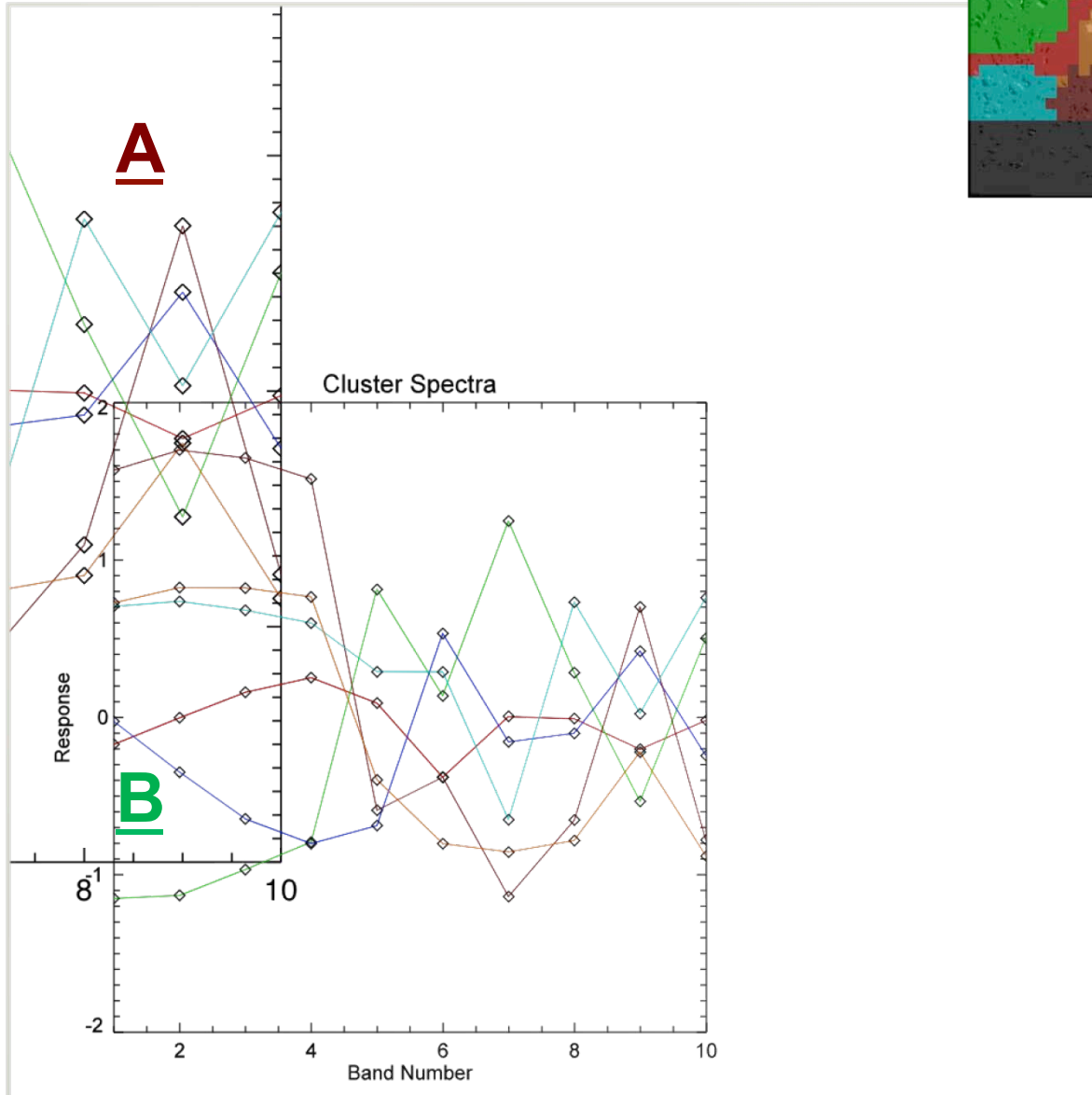
Mars Albedo



SOME REFERENCE IMAGES



Graphical Representation of Clustering



Cluster map of several GRS/HEND datasets

<u>Band #</u>	
<u>Neutron</u>	<u>Gamma Ray</u>
1 = Epithermal 1	5 = Cl
2 = Epithermal 2	6 = Fe
3 = Fast 1	7 = H ₂ O
4 = Fast 2	8 = K
	9 = Si
	10 = Th

EXTENSIONS OF
CLUSTERING



- Linear combination of neutron flux in each energy band has several possibilities
 - Direct correlation with specific elements without the need of GRS
 - Broader correlations such as geologic tendencies
- LEND provides us with more neutron data to observe
 - Comparisons with Prospector GRS results and obtained physical Lunar Samples.
- Other missions with neutron spectroscopy capability and not GRS may still yield elemental composition results

LRO AND FUTURE PLANETARY MISSIONS



- Rowan
 - David Klassen – Research advisor
 - Samuel Lofland – SPS advisor
 - Paul Abazia – previous SPS Intern
- SPS
 - Kendra Rand
 - Gary White
 - Entire staff – for making me feel welcome my first week
- NASA
 - Larry Evans – Advisor
 - Tim McClanahan
 - James L. Harrington, NASA/MU-SPIN
- This work was supported by a grant from the NASA-LEND-SPS Scholars Program!

ACKNOWLEDGEMENTS

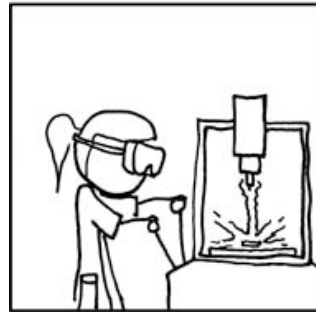


PLEASE
ask questions/make
comments!

SUGGESTIONS?



MOVIE SCIENCE MONTAGE



ACTUAL SCIENCE MONTAGE

