IBEX Creates an Unusual Image of the Sky!

NASA's IBEX satellite recently made headlines by creating a picture of the entire sky, not using light but by using cosmic particles called ENAs (Energetic Neutral Atoms). These fast-moving atoms flow through the solar system. Some of them reach Earth, where they can be captured by the IBEX satellite. By counting how many of these ENAs the satellite sees in different directions in the sky, IBEX can create a unique 'picture' of where ENAs are coming from in space.

The big surprise was that they were not coming from all over the sky as expected. They were also coming from a specific band of directions as we see in the image to the left. This image has the same kind of geometry as the map of the Earth below it! It is called a Mollweide Projection, except that instead of graphing geographic points on Earth, the IBEX image shows points in outer space!

	A	B	C	D	E
1					
2					
3					
4					
5					

Data String:
A5, E2, B2, D4, C3, A1, E4, C3, D4, B2,
D4, B3, C4, E5, D5, D4, C2, D3, B1, E5,
A2, C3, D5, C5, D4, E4, D3, C4, B4, D2,
E3, C1, B5, A3, E1, A4, D1, B3, C2, E3

The IBEX satellite detected a series of particles entering its ENA instrument, and was able to determine the direction that each particle came from in the sky. The grid above shows a portion of the sky as a 5x5 grid with columns labeled by their letter and rows by their number. The data string to the right shows the detections of individual ENA particles with their direction indicated by their cell. 'A5, E2, B2…' means that the first ENA particle came from the direction of cell 'A5', the second from cell 'E2' and the third from cell 'B2' and so on. In some ways this process is like the 'call out' during a Bingo game, except that you keep track of the particle 'tokens' in each square to build a picture! Let's look at an example of constructing an ENA image.

Problem 1 - From the hypothetical data string, tally the number of particles detected in each sky cell in the grid. Select colors to represent the number of ENAs to create an 'image' of the sky in ENAs! How many particles were reported by this data string?

Problem 2 - Suppose that cell B2 is in the direction of the constellation Auriga, cell C3 is towards Taurus and cell D4 is towards Orion, from which constellation in the sky were most of the ENAs detected?

	A	B	C	D	E
1	1	1	1	1	1
2	1	2	2	1	1
3	1	2	3	2	2
4	1	1	2	5	2
5	1	1	1	2	2

Problem 1 - Answer above. Students can select yellow = 5, orange=3, red=2 and blue=1 as an example and colorize the table. This is an example of using 'false color' to highlight data in order to reveal patterns. This technique is used by scientists, but should never be confused with the 'actual' color of an object. If you add up the number of ENAS in the data stream you get 40 ENAs being reported.

Problem 2 - The most ENAs recorded in any of the cells is '5' from Cell D4, which is in the direction of the constellation Orion.

The image below shows a close-up of actual IBEX data revealing the individual sky cells that make up the image. The color bar below shows the relationship between the color used, and the number of ENAs detected in each sky cell (called the particle flux).

IBEX–Hi Differential Flux (0.9–1.5 keV)

0   100   200   300 366
ENAs/cm^2/second/steradian/keV