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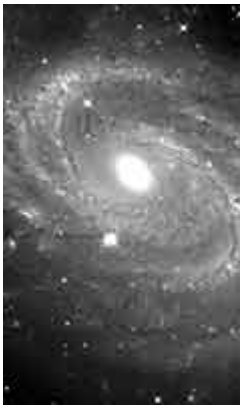
Taking a Grand Virtual Voyage in the Milky Way

by **Kent Cheatham**



After a few friends had raised their brows as to why I was spending so much time pursuing my newfound hobby, astronomy, I decided to make a pictorial tour to answer their looks (and concerns for me). You see, whether skimming the alien atmospheres of the nearby worlds in the Solar System or slipping through the lightyear-long strands of luminous gas in the remote Eagle nebula, you are participating in this Cosmos.

The links to images on the web follow each introductory statement in the following itinerary, but please stay with the tour until the end as you and your students follow the links (we don't want anyone left behind!). Remember that the experience is only a sampler for the greater journeys you can take later. Make a note which spots interest you the most, and return to those locations later, using them as the starting points for other voyages. Bon Voyage!

All Aboard

As we leave Earth we look back as the Space Shuttle astronauts did when they snapped this picture.

http://www.nineplanets.org/earth.html

We pass the Moon in a breath's second as we pick up speed.

http://nssdc.gsfc.nasa.gov/image/planetary/moon/gal_moon_color.jpg

We're truly into the Solar System now and headed towards the Sun. It's getting hotter...

http://www.nineplanets.org/sol.html

As we slingshot around the Sun to pick up break-away speed, we see the first planet coming into sight -- barren Mercury.

http://www.nineplanets.org/mercury.html

Next up is bland Venus, which is quite often our Earthly evening or morning "star." Except for similarities in size and density, however, Earth and Venus -- sometimes referred to as planetary twins -- have quite different atmospheres: Tremendous atmospheric pressure and a surface temperature of 750 kelvins (enough to melt lead) make Venus an unpleasant place for us.

http://www.nineplanets.org/venus.html

Leaving sweltering Venus, we again pass Earth and notice clear weather over Saudi Arabia.

http://images.jsc.nasa.gov/images/pao/AS11/10075246.jpg

Our water world falls behind us, yet ahead is Mars, a planet known to have had large quantities of liquid water, too, in the distant past. As its atmosphere thinned, however, most of the Martian water evaporated into space.

http://www.nineplanets.org/mars.html

Woops, but we almost hit Phobos, Mars's larger moon!

http://www.nineplanets.org/phobos.html

Clearing the Martian region of space, we now must navigate the Solar System's asteroid belt. And what do we come upon, but the asteroid 243 Ida (pronounced "EYE-duh") and its tiny (1.5 kilometer) moon Dactyl ("DAK-til").

Gaspra, an inhabitant of the Asteroid Belt. Image courtesy of The Galileo Project and NASA.

http://www.jpl.nasa.gov/galileo/idamnclr.html

Past the majority of the small bodies in the asteroid belt, we continue outward until planetary giant Jupiter now looms ahead of us.

http://www.nineplanets.org/jupiter.html

Quite apparent are the belts and zones of the Jovian atmosphere -- and the Great Red Spot, an ancient storm more than twice the size of Earth, looks like a great red eye peering at us.

To our surprise, we see Jupiter has rings (very thin ones) somewhat similar to those of Saturn.

http://www.jpl.nasa.gov/galileo/callisto/p48188.html

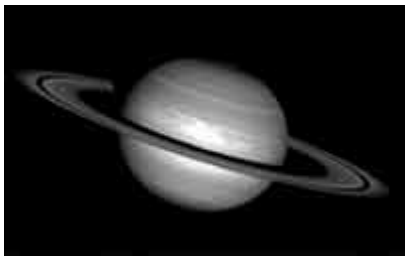
Hit the retro-rockets! Let's take a side trip by one of Jupiter's sixteen known moons. Io ("EYE-oh"), Jupiter's third largest and most colorful moon, is a world that is constantly flexed by the gravity of its parent planet; all this flexing makes Io a very active world with a number of belching volcanoes.

http://www.nineplanets.org/io.html

Getting back on course, we leave kingly Jupiter and approach the planetary ringmaster, Saturn. At almost twice Jupiter's distance from the Sun, Saturn is a very chilly planet.

http://www.nineplanets.org/saturn.html

Saturn's rings are among the most delicate structures you will find anywhere in the Cosmos. Only tens of meters thick, yet about 250,000 kilometers in diameter! Indeed, if you decided to make a scale model of the ring system using a sheet of paper of normal thickness, you would need a sheet bigger than the entire football stadium complex (stadium and parking lots, too) at a major university!



The planetary ringmaster, Saturn. Image courtesy of AURA/STScI and NASA.

http://ringmaster.arc.nasa.gov/saturn/voyager/saturn_rings.gif

Another Saturnian moon is Mimas ("MY-mas" or "MEE-mas"), a body that got smacked by something a long time ago -- just look at the size of that impact crater! It's almost one third the size of Mimas!

http://antwrp.gsfc.nasa.gov/apod/image/9904/mimas_vg1_big.jpg

Uranus's name has been the butt of many a joke (pardon the pun). And being composed almost entirely of gases has not helped its situation a bit (oh, somebody stop me).

http://www.nineplanets.org/uranus.html

Like the larger gas giants Jupiter and Saturn, Uranus also has a ring system, highlighted in this image collected by the Hubble Space Telescope.

http://oposite.stsci.edu/pubinfo/pr/96/15/A.html

And what about moons? Yes, Uranus has those, too - seventeen in all (and we're still counting). Here's Miranda, the innermost of the planet's large moons.

http://www.nineplanets.org/miranda.html

continue the voyage

Taking a Grand Virtual Voyage in the Milky Way

Leaving Uranus, we now move deeply into the outer Solar System and encounter that last gas giant planet, Neptune. With a gassy atmosphere full of methane, and (we believe) a deep ocean underneath, Neptune also has the swiftest winds of any planet in the Solar System...

http://www.nineplanets.org/neptune.html

Triton, largest of Neptune's eight known moons, is a place where you'll find terribly low temperatures and diverse landscapes. Here we see the so-called cantaloupe terrain.

http://www.nineplanets.org/triton.html

We think Triton may look quite a bit like Pluto, the most remote planet in the Solar System, but we have never been there. Even the Hubble Space Telescope is incapable of showing us much of tiny Pluto's surface. It is that far away and that small, measuring smaller than seven planetary moons!

http://www.nineplanets.org/pluto.html

Not to be outdone, however, Pluto has a moon named Charon ("KAIR-en"). Not too bad for such a small planet, huh?

http://oposite.stsci.edu/pubinfo/jpeg/PlutoCharon.jpg

Hold On! We're Leavin' the Solar System

Our journey continues as we leave the comfort of the Solar System, picking up speed and changing direction to intercept the Sun's closest stellar neighbors, the triple-star, Alpha Centauri system. Visible from the southern hemisphere back on Earth, the system rushes past.

http://antwrp.gsfc.nasa.gov/apod/image/alpha_cen_poss_big.gif

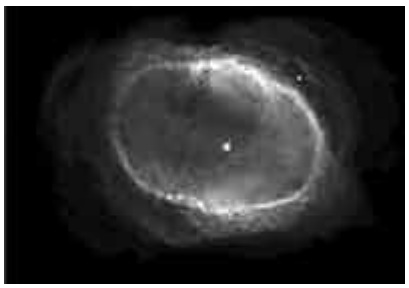
We still have a long distance to cover before we leave the Milky Way Galaxy -- tens of thousands of lightyears, as a matter of fact -- so let's stop by some interesting objects on the way.

Here we come to the Pleiades star cluster, a grouping of a couple of hundred stars, all relatively young. The Pleiades move through the Galaxy together, and here we see them passing through a cloud of interstellar gas and dust; note how their light is scattered by particles in the cloud, an example of nebulosity.

http://www.aao.gov.au/local/www/dfm/uks018.html

Since "nebulae" are my favorite objects, we'll stay here a minute. The Pleiades cluster contains an example of a reflection nebula; there are other kinds of nebulae.

Planetary nebulae are made of small shells of gas thrown off by dying, low-mass stars. The Sun will produce a planetary nebula as it dies in about six billion years. Here we see the Helix nebula, a good example of a planetary nebula; note the small bluish star at the very center of the nebula -- the dead star's core!



The planetary nebula NGC 3132. Image courtesy of AURA/STScI and NASA.

http://www.aao.gov.au/local/www/dfm/aat015.html

Emission nebulae are composed of gases (mostly hydrogen) that have been excited by stars' emitted radiation. When gas atoms get excited, they glow like a neon sign. The Great Nebula in Orion is 1500 lightyears away, but the young stars inside the Nebula excite the gas so much that the Orion Nebula is bright even to the naked eye.

http://www.aao.gov.au/local/www/dfm/aat019.html

Finally, dark nebulae are clouds of gas and dust which block the luminosity from any objects behind them. The Horsehead Nebula, then, also in Orion, appears as it does because dark material in the cloud completely blocks light from the stars beyond it.

http://www.aao.gov.au/local/www/dfm/aat036.html

Another dark example is the FANTASTIC Eagle Nebula. Visit each image in turn.

http://cfa-www.harvard.edu/cfa/hotimage/_m16broad.gif

http://oposite.stsci.edu/pubinfo/gif/M16Full.gif

Oops, it's time to move on! We've seen young stars in the Orion Nebula, older ones in the Pleiades, and still older ones in our own backyard (pssst -- the Sun is about five billion years old). But what about the oldest stars we can see anywhere? To find those, we'll need to head into the outer reaches of the Milky Way Galaxy -- into its tenuous halo.

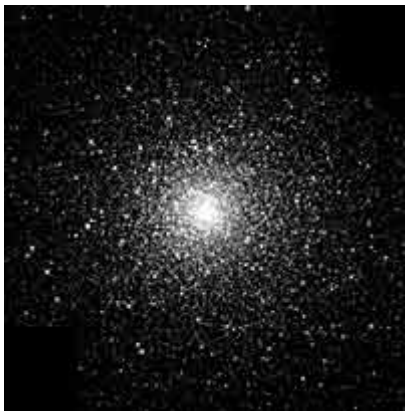
Up ahead is a globular star cluster. Composed of a few thousand to a few million of the very oldest stars in the Universe, globular clusters are beautiful markers to our galaxy's limits.

http://www.asahi-net.or.jp/~rt6k-okn/m3l.jpg

Whew! That was exhausting. But we have reached the edge of the Milky Way Galaxy. What lies beyond, moving swiftly through the practical emptiness of the Universe, are other galaxies -- some like ours, some not.

The vast majority are, like the Milky Way Galaxy and the Andromeda Galaxy (shown here), organized into clusters of galaxies. And each galaxy, you must recall, is made up of star clusters, nebulae, solitary stars, and planets.

http://www.galaxyphoto.com/jw_andromeda_6.JPG



Home to some of the oldest stars in the Universe, globular cluster NGC 6093 is striking in this Hubble Space Telescope image. Image courtesy of AURA/STScI and NASA.

Where to Travel Next?

You can spend a lifetime studying our one planet and not see it all. Maybe a number of lifetimes to study only a small portion of our Solar System. All these planets make up just one solar system, around one star, in one galaxy. Our medium-sized galaxy has a hundred billion stars, and we believe there are a few tens of billions of galaxies in the observable Universe. Where does this continuum of enormity end? We don't know, but we do know that there are countless voyages left to take.

To continue the virtual voyage beyond our galaxy, go to Kent Cheatham's "A Walk in the Stars" at http://www.ionet.net/~cheatham/astro/astrotour.shtml

Kent Cheatham is an avid amateur astronomer who lives just outside the lights of Harrah, Oklahoma. Although in his job he controls the state's electrical grid for Oklahoma Gas & Electric, his life centers around his wife and two children. His email address is cheatham@ionet.net.

continue to resources and activities

Taking a Grand Virtual Voyage in the Milky Way

Resources to Plan Your Next Trip

Online images and information

Planets and their Moons

http://www.nineplanets.org

Amateur Astro Images

http://www.aa6g.org/Astronomy/astrophotos.html

The Web Nebulae Site

http://seds.lpl.arizona.edu/billa/twn/top.html

Hitchhiker's Guide to the Moon

http://www.shallowsky.com/moon/hitchhiker.html

Pictorial Catalog of Messier Objects

http://www.seds.org/messier/photos/photos.html

The Astronomy Connection

http://www.seds.org/TAC/

Space Telescope Science Center

http://www.stsci.edu/top.html

Online astronomy magazines

Sky & Telescope

http://skyandtelescope.com

Astronomy

http://www.astronomy.com

Mercury

http://www.astrosociety.org/pubs/mercury/mercury.html

Activities to Enliven the Voyage

Design a Mars Colony

The Mars Millennium Project is an official White House Millennium Council Youth Initiative. It challenges students across the nation to look forward to the year 2030 and design a Martian colony for 100 humans. For information on participating in the Project, call 310.274.8787 (ext. 150), email mars@pvcla.com, or visit the website http://www.mars2030.net.

Making Magma Flow

Volcanoes have been discovered on several bodies in the Solar System. And while there are variations on Earthly magma volcanoes, the ones we see here are probably representative of most of those we see on other worlds. The Hawai'i Space Grant College, the Hawai'i Institute of Geophysics and Planetology, and the University of Hawai'i have a nice hands-on learning activity in which students how and why magma moves inside volcanoes. To reach the teacher's page for the activity "Gelatin Volcanoes," just hop to URL www.spacegrant.hawaii.edu/class_acts/GelVolTe.html.

Creating a Grapefruit Saturn

Study of Saturn's elaborate rings introduces students to many concepts — making shadows, light travel, making scale models. To address these topics in a simple, straight-forward manner for 10- to 11-year-old students, Lynda Filip and John Percy of the University of Toronto share a classroom activity that involves basic materials like glitter, paint, and…grapefruit. The activity is described online at http://www.astrosociety.org/education/publications/tnl/40/saturn.html.

How Far Are the Stars?

In the absence of understanding, we tend to think that faint stars are small and bright stars are big. We fail to take into account the fact that stars' apparent brightnesses are, in fact, a strong function of the stars' different distances from us. In this activity, created for PBS, teacher and students use Styrofoam balls, construction paper, and an overhead projector to demonstrate the distances to the stars. This activity, suitable for students from middle school through high school, is available online at http://www.pbs.org/deepspace/classroom/activity3.html.

Finding Your Way in the Milky Way

When we look at the sky, we see everything projected onto two dimensions. Objects near and far can be confused if we lack independent knowledge of those objects' distances. So how do we decide where things are in the Galaxy? In this online activity created by educationists associated with the Chandra X-Ray Observatory mission, high school teachers and students learn a little about navigating and mapping in the Milky Way Galaxy. The URL for the activity is http://chandra.harvard.edu/xray_astro/navigation.html.