SPRING 2005
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MIRA NEWSLETTER

Stephan's Quintet

Imaged with the MIRA 36" Telescope

Contents

Calendar of Events

Sunday, 22 May, 2:30-4:00pm Free tour of MIRA's Oliver Observing Station on Chews Ridge. Open to the public. Reservations are required; please call 883-1000.

Q&A

This feature is inspired by the questions we have received over the years from interested readers. If you have a question about an astronomical topic, please send it to us.

Cath Tendler-Valencia asks,

How long does it take the sun and moon to rise and set from top to bottom/bottom to top along the horizon? I assume the times are equal for the sunrise/sunset and the moonrise/moonset. Does the latitude matter? Do elevation and topography matter? Many thanks!

Wm. Bruce Weaver replies,

To answer the easy parts first, the time of year, latitude, and local topography do matter.

First, let's consider time of year and latitude. Imagine that you're at the North Pole. The sun circles you at different elevations above the horizon depending on the day of the year. It is highest at summer solstice and below the horizon at the winter solstice. Thus, there are days where it is partially set. The angle the path of the sun makes to the horizon and, hence, how long it take to set, varies with the time of year for every latitude except at the equator, where it sets perpendicular to the horizon. At the equator, however, its azimuth at rise and set varies throughout the year. These general concepts are the same for the moon, although it has a more complicated path through the sky with some cycles taking nearly 20 years.

How long it takes the sun or moon to rise or set is more difficult. This is strongly affected by the differential refraction of the atmosphere. This effect is so strong that, when the bottom of the sun appears on the horizon, if there were no atmosphere, it would have already set! So yes, the local horizon and elevation do matter as the effect of the atmosphere depends on how much you're looking through. The last part of the answer—what would be the shortest sunset—is somewhat indeterminate because of atmospheric refraction. Depending on atmospheric characteristics at the time of sunset, bits and pieces of the sun may appear above the horizon for a time. The shortest sunset will, on average, occur whenever the sun sets straight down, for example when viewed from the equator on one of the equinoxes.

The apparent motion of the sun slows as it approaches the horizon because atmospheric refraction, acting like a lens, bends the light of the sun around the limb of the earth. When the bottom limb of the sun appears to be touching the horizon, geometrically (e.g., if the atmosphere suddenly vanished) the sun has already completely set.

Thus, the shortest sunset is about 2 minutes, at the equator at the equinox with well behaved air above the observer.

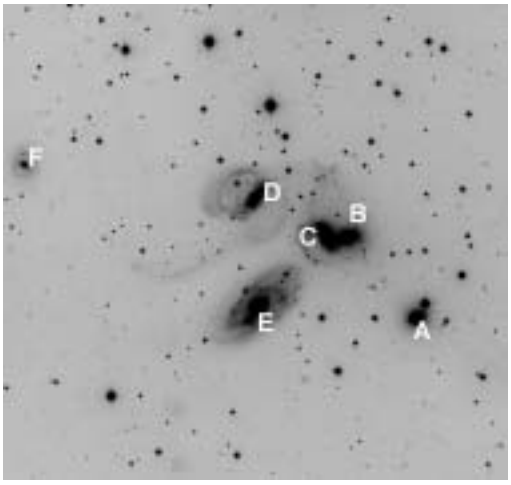
Personally, I like the pretty colors. Thanks for the question.

On the Cover

Stephan's Quintet, also known as Hickman Compact Group 92, is a cluster of galaxies in the constellation Pegasus. Note the wisps of material seemingly connecting the galaxies; these tidal gas streams indicate gravitational interaction. The color version of this image may be seen on MIRA's web page.

Sharp-eyed readers will note that there are actually six galaxies in the image. Galaxy E, whose redshift is different from that of the others, may be a foreground object, and galaxy F may or may not be a member of the group.

Quartet, quintet, or sextet?



MIRA Awarded Research Grant

MIRA has received a Theodore Dunham, Jr., Grant of $2,979 for the acquisition of special filters to study emission-line stars such as T Tauri stars, long a MIRA specialty. The grant was awarded by the Fund for Astrophysical Research from funds donated by the Institute for Space Observations.

While spectroscopy is the usual method of identifying objects with emission at the hydrogen alpha line (6563 Å), using filters and direct-imaging cameras will enable us to reach fainter stars than the MIRA spectrograph is capable of recording. Moreover, a filtered direct image can screen hundreds of stars simultaneously, identifying candidates for spectroscopic follow-up. One of the filters in this two-filter set was designed by Friend of MIRA Wayne Rosing for his wide-angle hydrogen-alpha survey of the southern sky (Gaustad et al., *Publications of the Astronomical Society of the Pacific* 113:1326-1348).

We will use these filters later this spring to examine a star-formation region in the Pelican Nebula, pictured below. Our thanks to the Fund for Astrophysical Research for this support!

Star-formation region in the Pelican Nebula (MIRA image). MIRA's new filter set will allow us to identify emission-line stars in this and other areas.

MIRA Receives a Challenge Grant for the High-Resolution Spectrograph

Dr. Wm. Bruce Weaver

Faithful readers of the *MIRA Newsletter* may remember the article in the Fall 2004 issue ("Reading the DNA of the Universe II: Up Close and Personal" Vol. 27, No.3) in which we described the excitement of studying the atoms and molecules of the Universe with very high spectral resolution. By spreading the light of celestial objects into very fine divisions of color, we can probe the most closely held secrets of these stars and nebulae. We've been eager to extend MIRA's research capabilities by designing and building one of the highest resolution astronomical spectrographs in the world.

How does MIRA compete with the world's largest telescopes with an instrument whose function is to spread the light out as thinly as possible? We don't; our researches are complementary.

The large telescopes are used to study the faintest objects they can but our instrument will study objects selected from the brightest nearly million objects in the sky that they pass by. These brighter objects contain many of the most interesting objects in the sky: the hot shell stars of the Pleiades, the everyday stars swaying almost imperceptibly to and fro from the gravitational tug of giant planets, stars barely formed, giant cool stars in their annual pulsations of 100,000 in brightness, stars shooting jets of superheated gas into space, ... well, the list itself could fill this newsletter.

The funding for our dream machine is suddenly half completed! An anonymous donor has offered a $125,000 one-for-one challenge grant towards the construction of the new spectrograph. This will be a grand instrument capable of great astronomical research, and now we have a chance to start the detailed design and construction. Such a major instrument will be a many month project but, hopefully, the construction will not be limited by our ability to match the challenge. If you'd like to contribute to this exciting instrument, please give us a call. You can help us develop a world-class spectrograph on the Central Coast.

The Monterey Institute for Research in Astronomy gratefully acknowledges memberships and gifts for 2004 from individuals, families, corporations, and foundations

The spring *MIRA Newsletter* is our opportunity to honor those Friends of MIRA who honor us with their support. We are ever conscious of your trust in us to spend your gifts in ways that reflect your intentions and our stated goals.

As always, there are many more Friends in the lower categories than the highest. While we always encourage donors to move up a category when they can, the total support of the more modest categories is essential to continuing the everyday education and research functions of MIRA. These are especially important to our ongoing education programs that are not bold new initiatives but the routine introduction of the amazing wonders of the Universe to bright new faces.

It's thrilling to share what we know and don't know about the cosmos with students motivated not by grades but by the joy of learning what thousands of years of human inquiry have brought to them for their wonder and amazement. Which ones of them will add some unique piece to the cosmic puzzle?

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New Faces at MIRA

Kim Postgate, MIRA's new Administrator

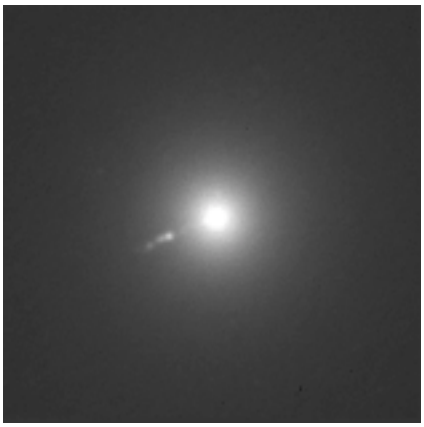
Technician Holly Keifer and Director Bruce Weaver discuss infrared imaging.

The Spring Sky

by Dr. Whitney Shane, MIRA's Charles Hitchcock Adams Fellow

Fixed Stars

The intrinsically brightest objects in the sky are the quasars. This is a popularization of the original and more descriptive name, quasi-stellar objects. They were so called because, although they looked like stars, their spectra showed that they were very distant objects and therefore much too bright to be any kind of star. These objects are not found in our part of the universe, and they appear to be associated with the early stages in the formation of large galaxies, a process that took place when the universe was only a few billion years old. We believe that in this stage the surrounding matter was falling into the new galaxies at a rapid rate. Collisions of large gas clouds, and even some stars, caused loss of orbital energy, so that a large mass collected in the gravitational center and a black hole formed. The further accretion of mass by this black hole released huge amounts of gravitational energy, causing the object to radiate very strongly, outshining all other light sources in the universe.



M87 imaged with the MIRA 36-inch telescope. This 30-second exposure shows only the bright inner regions of the galaxy; on a longer exposure, the galaxy image would be much larger and the jet invisible.

It is not clear how long any particular quasar could last in this active state, but the statistics of quasars, as now observed, places an upper limit of about a billion years, and it may well have been much less. The process will end when the available fuel is exhausted. Those stars orbiting near the black hole can be captured, as can those orbiting at a greater distance but in very eccentric orbits. We refer, rather obscurely, to stars in such orbits as being in the "loss cone," because of all the stars in a given location, only those with velocities within a very restricted range will be subject to capture, and thus to loss. Once captured, these stars will no longer be available as fuel, and the quasar will fade into obscurity.

This is not the end of the story, because the black hole continues to exist. In many galaxies, including the Milky Way and our nearest large neighbor, Messier 31, we find evidence for such a central black hole. As long as it is not being fed, such a black hole will not radiate and thus not be directly observable. However, its gravitational field will influence the distribution and motion of nearby stars. When we observe stars with high velocities orbiting the centers of galaxies, as we do in the cases mentioned above, as well as many others, we must conclude that there is a very massive object in the center. Although we have no direct proof that this object is a black hole, it seems by far the most plausible explanation. We sometimes refer to objects of this sort as "dead quasars", and we now have every reason to believe that these are common, even in the nearby galaxies.

A dead quasar may, however, not remain dead. If a star, somewhere in the galaxy, should be diverted into the loss cone, for example by a close encounter with another star, then the quasar could return to life briefly, as it gobbles up the material of this unfortunate star. Sometimes this will happen quietly, as the star plunges straight into the black hole. But sometimes the star will be disrupted by tidal forces and the resulting gas stream will be absorbed by the black hole, causing it to temporarily brighten. Such an event might occur in a dead quasar once in a few thousand years, making the monitoring of nearby large galaxies worthwhile.

If a galaxy harboring a dead quasar should absorb a nearby small galaxy, as we believe happens from time to time, particularly in clusters of galaxies, then matters become even more interesting. The entry of the new material will disturb many stellar orbits, and the loss cone will very likely be replenished so that the black hole will be once again fed and the dead quasar will come back to life. This may well be the case in Messier 87, one of the brightest galaxies in the Virgo cluster. This galaxy may have become the giant elliptical that it is by capturing neighboring small galaxies. Such an event may have happened quite recently, causing the central black hole to become active. The galaxy has quite a bright nucleus, but the activity does not stop there. The nucleus shows a bright jet of material, apparently moving with relativistic velocity, as well as a fainter counter jet. Although the bright material is confined to the center of the galaxy, the jet extends far beyond the optical limits of the galaxy as seen in radio radiation. This originates from the relativistic material encountering intergalactic gas,

causing it to decelerate and emit synchrotron radiation. Although jets of one sort or another are often found associated with quasars, their origin is not well understood. The rotation axis of the central region no doubt plays an important part in determining the direction.

Although far less bright than the distant quasars, Messier 87 shows signs of the kind of activity that must have been common in the exciting early stages of the universe. Observers with modest sized telescopes can easily observe Messier 87 in the spring sky. It is close to the center of the Virgo cluster and about 10 degrees east of the white second magnitude star Denebola (Beta Leonis). The visual observer will see no sign of the jet, which is small and faint compared to the galaxy itself, but he may be assured that it is really there.

Planets

Mercury will be very low in the morning sky in late April and early May, but it remains difficult for northern observers. It reappears in the evening sky late in June. On June 27 it will be very close to Venus (0.06 degrees separation), but the closest approach will occur in the morning hours.

Venus will become visible in the northwest evening sky during May, but it will remain very low in the twilight sky during the remainder of the quarter.

Mars will be low in the southeastern morning sky during the whole quarter, with visibility improving only modestly as the quarter comes to an end. It will be 1.2 degrees south of Neptune on April 12 and the same distance south of Uranus on May 14, perhaps making it somewhat easier to find these elusive objects. A lunar occultation of Mars on May 31 will not be visible from our region.

Jupiter is at opposition on April 3 and moves into the evening sky as the quarter progresses. There will be three occultations of Jupiter by the Moon during the quarter, none of them visible from our part of the world. Those wishing to observe an occultation may be interested in the lunar occultation of Antares on the night of May 23.

Saturn is well placed for observation in the evening sky at the beginning of the quarter, but moves westward and is lost in the twilight by early June.

Meteor Showers

Two of the spring meteor showers, the Lyrids, on April 22, and the Pi-Puppids, on April 23, will be spoiled by a nearly full moon. However, the most prominent shower, the Eta-Aquarids, will be largely free from moonlight. This shower, which is associated with Comet Halley, may be observed between the middle of April and the end of May. The main peak is expected on May 5, but secondary peaks at variable times are often observed. The shower is observable during the morning hours and best observed from southerly latitudes.

Comets

Comet 2440 Q2 (Machholz) remains the brightest comet currently visible, and it should be well placed for observation from the northern hemisphere.

A new comet, LINEAR (2005 A1) is brightening rapidly, but until June it will be observable only from the southern hemisphere. LINEAR(2003 T4) is also currently best seen from the southern hemisphere.

LINEAR (2003 K4) will still be visible in the evening sky at the beginning of April before disappearing into the twilight.

Periodic comet 78P Gehrels will be visible in the evening sky until May.

Another periodic comet, 9P Temple is attracting much attention because of the Deep Impact project planned for July 4. Currently the comet is rather fainter than was expected.

Eclipses

There will be two eclipses in April. The first one is of an unusual type, a so-called hybrid eclipse, where over part of the path of the central eclipse there will be totality and over another part it will be seen as an annular eclipse. This will happen when the apparent sizes of the sun and moon are nearly equal. As the path approaches the sub-solar point, the moon will appear a little larger, and there will be a brief total eclipse. Where the path is far from the sub-solar point the moon will appear a bit smaller and will not quite cover the solar disk, resulting in an annular eclipse. This eclipse will take place on April 8, but even the partial phase will be visible only from the very southernmost part of California. The path of totality extends over the Pacific Ocean and finally reaches landfall in Panama.

The second eclipse is a penumbral lunar eclipse, where the moon passes close enough to the shadow of the earth that a part of the sunlight is obscured. This will not be a spectacular event, the moon showing only modest dimming and some coloration. A small part of the moon does not even pass through the penumbra and will remain fully illuminated during the whole eclipse. The eclipse will be visible from our area on the early morning of April 24 and will end shortly before moonset.

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Welcome to our new Friends

Albert M. Bottoms
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Thanks!

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