WINTER 2007
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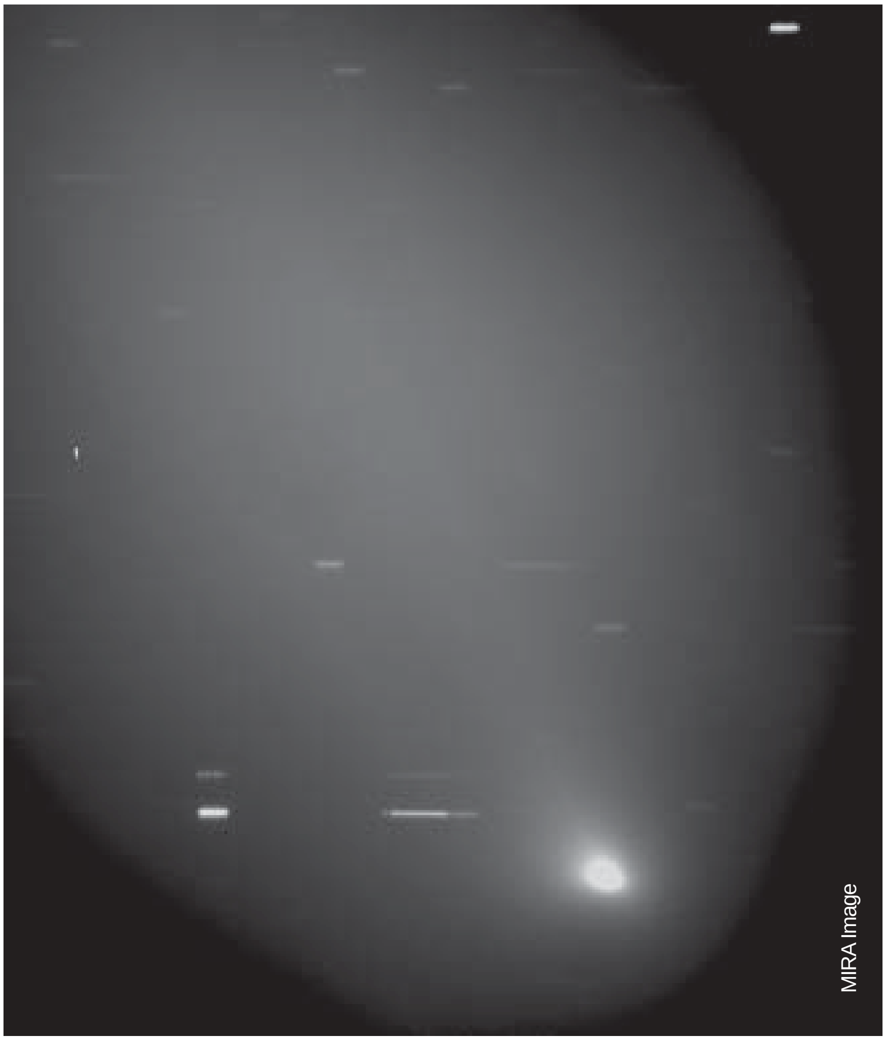
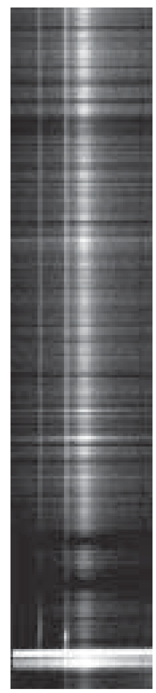
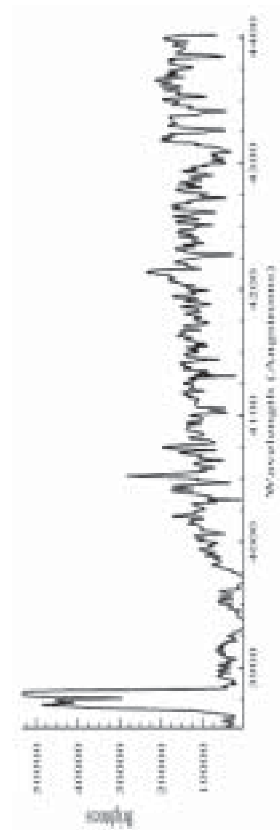
MIRA NEWSLETTER







The picture at the left is a composite of several images of Comet 17P / Holmes made on 11 November 2007, when the comet had developed a tail. The stars appear as short streaks from the motion of the comet from west to east during the imaging session.

To the right of the large image are a spectrum taken on 25 October, and a plot of the spectrum. The comet was 150 million miles from earth. The bright emission feature at 3880 Angstroms is cyanogen (CN). The two narrow vertical lines are artifacts; the fuzzy vertical line is the comet nucleus. For more on this event, see “On the Cover,” p. 5.

Comet Holmes Brightens 500,000 Times

Contents

Calendar of Events

January 2008 (date TBD) The Bonestell Lecture by Dr. Alexei Filippenko of UC Berkeley: "Once in a Century: the Milky Way Supernova of 1987." Monterey Peninsula College, Lecture Forum 102.

From the Director

Autumn Nights

Each of the seasons stirs special emotions in all of us. For me, autumn brings long, cool, deep nights filled with many dark hours to study the stellar nurseries that reveal themselves in the rising winter Milky Way. Quiet hours of humming telescope motors, computers, and glorious constellations sailing across the sky. These are the hours that provide the days of analysis during the wet and windy days of winter.

But what value is a grand night of observing without the facilities to open each observation later like a birthday present to see what new hints the cosmos gives us of its true nature? The deep satisfaction of a night well observed must be complemented with careful understanding of the gathered data. The build-out of the highbay will provide those facilities.

The anticipation of adequate room for our students, staff, library, and classrooms is now palpable at the Astronomy Center. How wonderful it will be to unpack the interns, astronomers, staff, volunteers, and computers out of one small room into space in which they can all work effectively. Equally delightful will be a library consolidated from its current three locations and numerous boxes. The sunlight-filled central atrium will feature a glass wall of names of Friends and foundations that have helped to make it possible.

Autumn, the harvest season, is also the time of year when many make their most significant donations of the year. We're close to completing the fundraising for the build-out of the Richard W. Hamming Astronomy Center highbay. Completing the build-out will complete the fall experience. Great data from Chews Ridge analyzed and shared with our Friends and students in a great new facility can be realized with your help.

—Bruce Weaver

MIRA Astronomers to Offer Course in CSUMB Lifelong Learning Program

The Osher Lifelong Learning Institute (OLLI) at CSUMB will offer a course taught by MIRA astronomers. Details are still being worked out, but the course will probably begin in late March and continue through early May, when it will culminate in a tour of the Oliver Observing Station on Chews Ridge.

Details will be posted on the MIRA web site, www.mira.org.

A calm autumn dawn ends a long but wonderful night of observing.

Student Research at the Oliver Observing Station

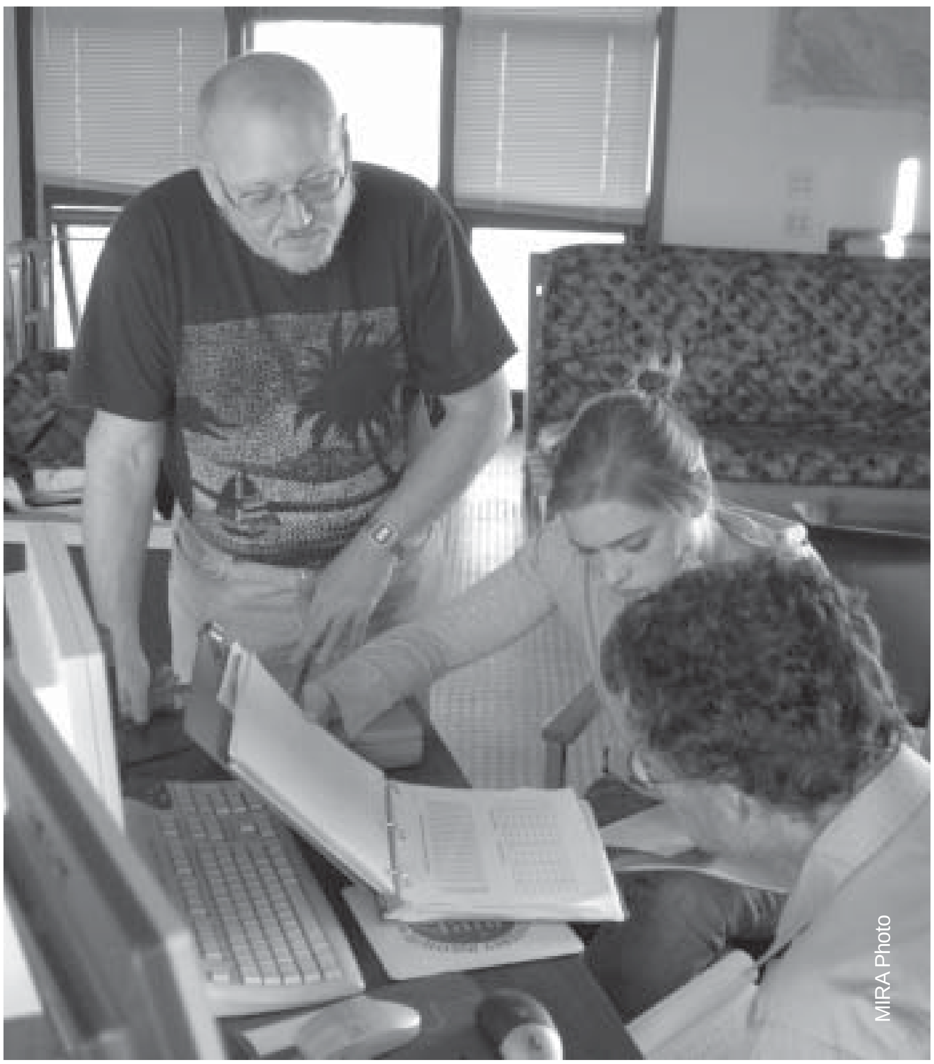
by Arthur Babcock

When MIRA was incorporated in 1972, the founders set themselves a dual mission: research and education in astronomy. Readers of the *Newsletter* are familiar with some of our educational activities: school visits, public star parties in Garland Park and the Weaver Student Observatory, and, of course, our popular series of public lectures.

Sometimes, these two missions merge into a single project. This is often the case with our summer high school interns, who usually assist MIRA astronomers on active research projects. And sometimes, a student works on his or her own project, assisted by astronomers.

Such was the case when Hannah Alberts, a senior at Scripps College, visited the OOS last October with her adviser Dr. Steve Naftilan for a two-night observing run. Hannah plans a yearlong research project, looking at spectral profiles of stars in the Pleiades, analyzing the data and comparing them with historical results.

As her project develops, she may focus on the star Pleione. Pleione is a shell star, a rapidly rotating star of spectral type B. It periodically ejects a gaseous "shell," which changes its spectrum dramatically. The star has been studied since the 1930s, but no one really knows what causes the ejection, and much remains to be learned about it. On page 4, Dr. Weaver discusses some of the observations.



Hanna Alberts, Dr. Bruce Weaver (top) and Dr. Steve Naftilan (bottom) plan their observations of stars in the Pleiades open cluster.

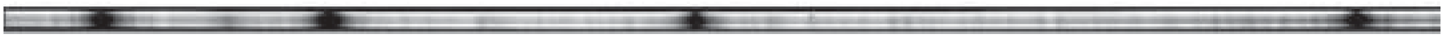
Hannah's research project will serve as her senior thesis as a physics major at Scripps. She has always been interested in math and science, and as a child was captivated by telescopic observations of Saturn with her dad from their Texas back yard. As a high school student, she planned on majoring in chemistry in college, but once she got to Scripps, physics seemed to correspond more closely to her interest in science.

But her interests do not end there. After graduation, she plans on spending two years teaching English in Russia under the auspices of the Fulbright program. After that, graduate school is a possibility, perhaps in environmental science or science policy.

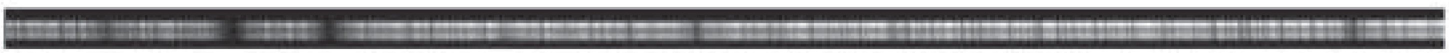
Wherever Hannah's path takes her, we at MIRA are happy to have helped her along it.

A Look at Pleione

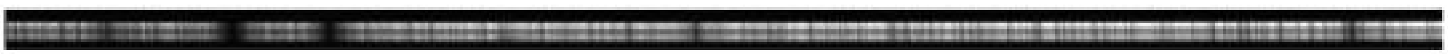
by Dr. Wm. Bruce Weaver



Spectrum of Zeta Pegasi, type B8V, temperature of 11,400 degrees Kelvin

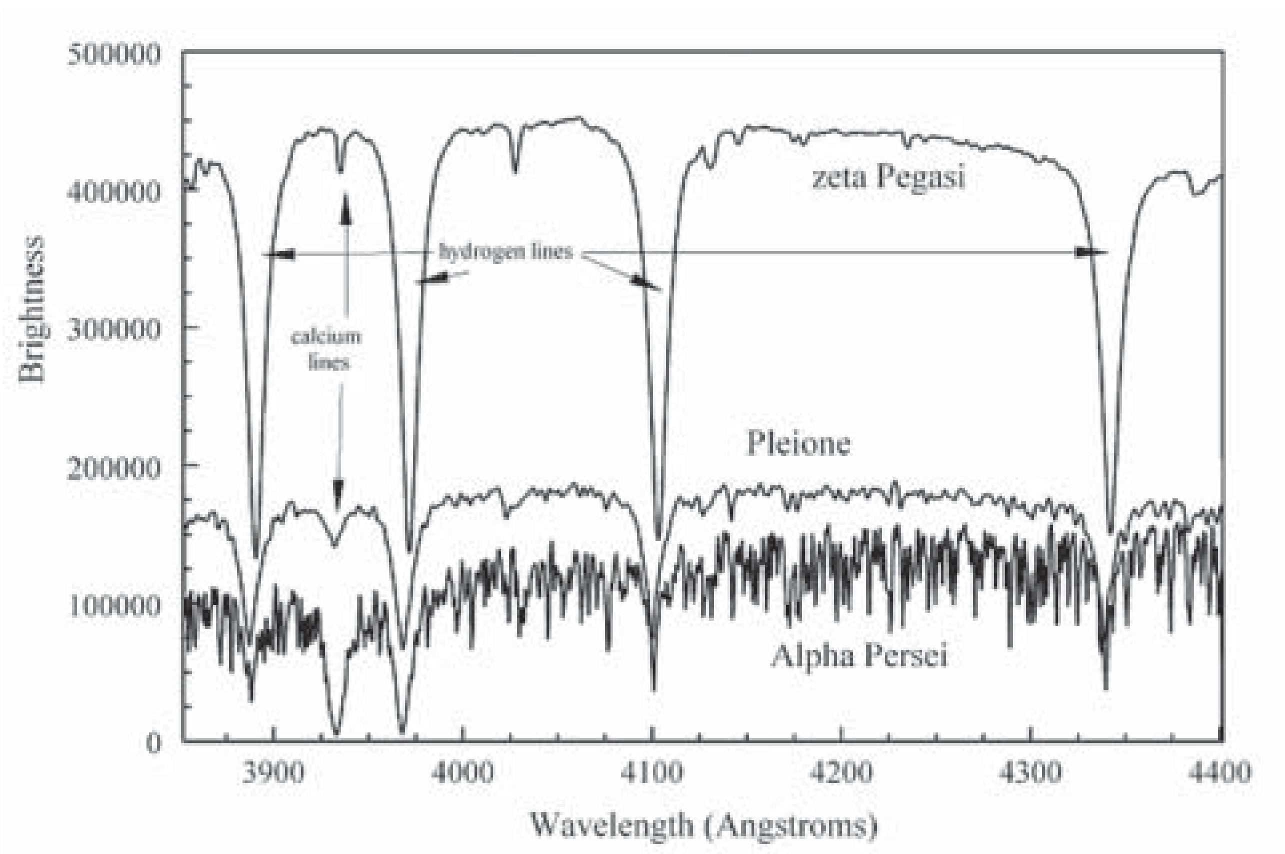


Pleione, type BeIV, temperature 11,700 degrees Kelvin



Mirfak (Alpha Persei), type F5Iab, temperature 6,370 degrees Kelvin

In the spectrum of the normal B-type star Zeta Peg, very little is visible except the dark hydrogen absorption lines. For Pleione, of essentially the same temperature and chemical composition as Zeta Peg, the absorption lines of many more elements are apparent. These lines match many of the lines in Mirfak, a cool supergiant. Our suspicion is that Pleione, which is known to blow off shells of gas every few decades, is showing a cool, semi-transparent shell of gas (evidenced by the non-hydrogen lines usually seen only in cooler stars) through which the underlying star (evidenced by the strong hydrogen lines) shines. This is even more apparent when a plot of the three spectra is made (below).



On the Cover

On 24 October, Comet 17P/Holmes suddenly brightened from magnitude 17 to 2.5—a factor of about 500,000 times—and became a naked-eye object in Perseus. MIRA's Dr. Russ Walker was in Ogden, Utah, when he heard about the comet, and on 25 October, he telephoned the Oliver Observing Station where he spoke to Dr. Bruce Weaver, who was making observations of the Pleiades at the time (see story, p. 3). Dr. Weaver was able to record the spectrum of the comet, and on 7 November, he and Dr. Arthur Babcock made several direct images of the comet.

It has been suggested that the outburst was caused by a meteor impact. However, Comet Holmes underwent a similar large outburst in November, 1892, when it was first discovered. Also, all the early images show a completely spherical coma immediately after the extraordinary brightening. The Deep Impact event into Comet 9P/Tempel 1 showed strong elongation (see the MIRA images in the Summer 2006 *Newsletter*). Thus, it seems likely that the brightening was caused by a fairly uniform 'explosion' as ices, trapped under the surface of the comet, evaporated due to solar heating, causing an increase in pressure until the crust of the nucleus could no longer hold it in.

Ralph Knox Foundation Supports MIRA High-Resolution Spectrograph

The MIRA high resolution spectrograph project received a timely boost from the Ralph Knox Foundation in the form of a $15,000 grant. Consider the spectrum of Alpha Persei on page 4. The new spectrograph will have 25 times the resolution and cover the entire visible spectrum which is 12 times the amount possible with the current spectrograph. This will help MIRA astronomers decipher the jumble of spectral lines and probe the mysteries of many unusual, and even normal, stars.The list includes stars with planets: how are they different from stars without planets? Is there a signature in a single spectrum that will identify probable candidate stars with planets? Other topics include understanding the hot outer atmospheres of cool young stars, the atomic physics of atoms in stars with strong magnetic fields, and the long-time mystery of diffuse interstellar matter. This donation is especially timely because the TABASGO Foundation has offered a 4096x 4096 CCD chip to use in the spectrograph. Twice the size of our original detector design, this chip will permit us to greatly improve our radial velocity accuracy, an important factor in the search for extra-solar planets. Electronics and cooling for this larger sensor, however, will cost as much as the entire smaller system. With the Knox Foundation grant, we are now set to proceed with the larger sensor. And we have settled on a name: Mechelle for MIRA echelle spectrograph. The echelle grating is the heart of the spectrograph, breaking the light into its component colors.

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.

Numerous correspondents have asked whether an image circulating on the Internet can possibly be genuine. The image is claimed to show sunset at the North Pole.

It's pretty, but is it real?

Dr. Bruce Weaver replies,

It is a lovely picture but is obviously totally bogus. As we all know if we've ever been outside, the sun and the moon are of identical apparent sizes on the sky. It is this amazing coincidence that makes solar eclipses possible. It also makes the picture a fabrication.

In addition, at the north pole, there would be no sunset in the standard sense. For a little more than half a year, the sun just circles at some altitude. Finally, it just circles down to below the horizon. Sunset takes days.

By the way, this picture, and its accompanying e-mail, have been around for a while. I first saw them 18 months ago. Like most hoaxes, they live forever on the Internet.

Dr. Chung-Pei Ma Lectures on Dark Matter: The Other Universe

by Rod Norden and Kris Houser

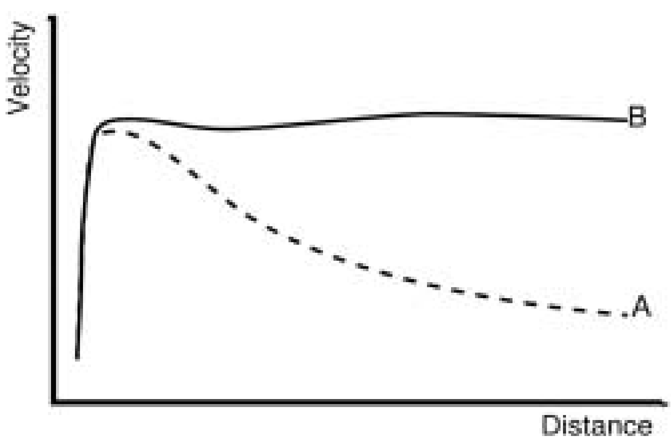
On 27 October, 2007, the Friends of MIRA were treated to a very informative, humorous, and amazing review by Dr. Chung-Pei Ma of UC Berkeley of the modern research into the origin and structure of the universe, or cosmology. She summarized the current theoretical cosmological research. She also discussed the mystery of the missing material in the universe, the dark matter and dark energy that cannot be seen but must be deduced from observations.

She began by relating a humorous story about how folks often misunderstand what she does for a living. When she says that she studies *cosmology*, many people think she means *cosmetology*, and her first slides reminded us that *cosmology* and *cosmetology* are **not** related!

Dr. Ma said the current view of the universe results from a number of discoveries over the past century which indicate that most of the matter in our universe is "dark" or invisible.

Discovery 1:

In the 1930's, astronomer Fritz Zwicky attempted to determine how clusters of galaxies could be gravitationally stable. He estimated the amount of visible material present in the clusters and found that there was too little matter to account for the way galaxies seemed to remain together.



Curve A represents the expected rotation of a galaxy rotating according to Keplerian dynamics; curve B is a representative observed galactic rotation curve. The flatness of the B curve suggests that there is a great deal of unseen ("dark") matter in the outer regions of the galaxy.

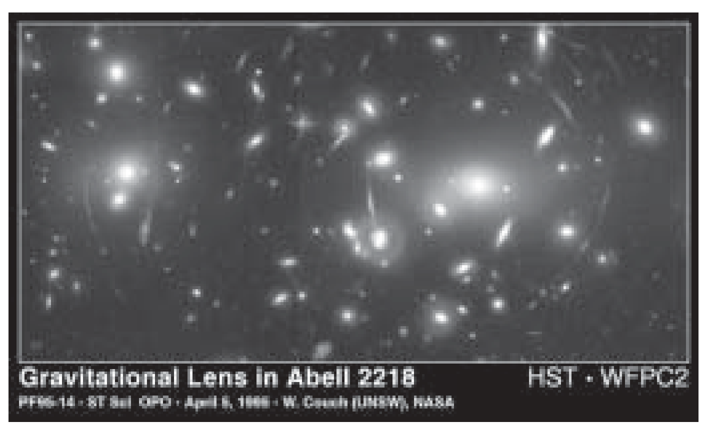
Discovery 2:

In the 1970's, astronomers discovered that gas revolving around the centers of galaxies was moving much faster than the speed expected. In our solar system where the Sun has most of the mass in the center, planets revolve slower as their distance from the center increases, as Kepler's Laws indicate. This was not found to be true for the stars and gas in galaxies whose rotational velocities indicated that mass is fairly evenly distributed around and throughout a galaxy, even though the amount of visible material decreases away from the center.

Discovery 3:

Einstein predicted that light would bend in passing a very massive object. This prediction was confirmed by photos taken at the total solar eclipse in 1919, when the light of a background star was deflected by the amount predicted in passing near the eclipsed sun.

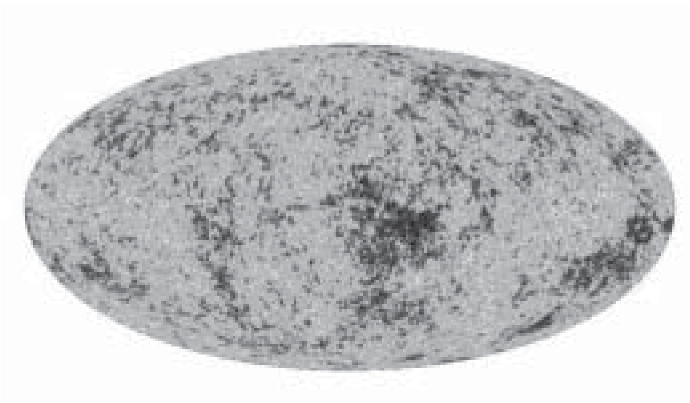
Currently, we have found many examples of this phenomenon (called gravitational lensing) in which light passing near massive foreground galaxies and clusters of galaxies is deflected into multiples images and arcs. The deflected light can be analyzed to indicate the total mass of the deflector. Again, these studies indicate that the light is being bent by much more mass than is visible in the deflecting object.



Discovery 4:

The Big Bang theory predicts that the early universe was a very hot place and that as the universe expands, the gas within it cools. Thus the universe should be filled with radiation that is literally the remnant heat left over from the Big Bang, called the "cosmic microwave background radiation", or CMB. It was discovered in 1965 by Arno Penzias and Robert Wilson from Bell Labs, and further refined by the COBE satellite and much further refined by the WMAP satellite, both of which exhibit increasing resolution of fluctuations.

These cosmic microwave temperature fluctuations are believed to trace irregularities in the density of matter in the early universe, as these fluctuations were imprinted shortly after the Big Bang. This being the case, the CMB can reveal a great deal about the age, composition, development and geometry of the universe.



The WMAP satellite's map of the cosmic microwave background. NASA-WMAP image.

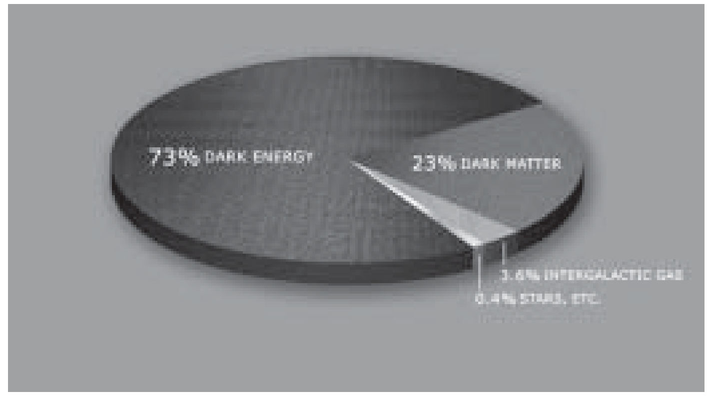
Discovery 5:

Type Ia supernovae are believed to occur when white dwarf stars draw mass away from their neighboring binary companion until the dwarf star becomes unstable and explodes. This type of supernova has a consistent peak luminosity because of its uniform mass at the time of detonation. This predicable absolute luminosity allows these supernovae to be used to measure the distance to their host galaxies, since apparent brightness decreases with increasing distance. Astronomers studying very distant Type Ia supernovae have found an accelerating expansion of the universe.

Summary:

In the process of describing these discoveries, Dr. Ma summarized the state of the current cosmological research. The universe appears to be about 13.7 billion years old. She then demonstrated the derivation of the pair of "magic numbers" which are the relative proportions of dark matter and dark energy. Scientists now believe the universe is composed of

- 23% dark matter
- 73% dark energy
- *only* 4% visible matter (atoms)



Everything we see constitutes only 4% of the universe. NASA image.

Dark matter appears to consist of various elementary particles and not dead stars and planets, brown dwarfs, neutron stars, and black holes. Dark energy appears to be a repulsive force opposite from our normal attractive gravity. There is much more to be learned about both of these entities.

A lively Q and A session followed the talk. One question in particular led to the closing humor of the evening. Someone asked if there had been any practical value to the study of cosmology. Dr. Ma discussed the new detectors we have for most of the electromagnetic spectrum and several examples of devices arising long after fundamental discoveries in physics. Dr. Bruce Weaver related a story about Michael Faraday, who discovered the principles used in electric motors today. When asked of the practical value of electricity after giving Parliament a demonstration, Faraday replied "One day sir, you may be able tax it."

The Winter Sky

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

Fixed Stars

With the Milky Way still in full view, we can permit ourselves to dwell once more upon our favorite subject (no secret here): the structure and formation of stellar systems, and of the Milky Way itself. We have known now for close to a century that the Milky Way was a spiral galaxy, but it was only in 1962 that Eggen, Lynden-Bell and Sandage proposed a model for the formation of the Galaxy which seemed to account fairly well for the observations. They suggested that a large rotating cloud of gas, in which star formation had already begun, contracted under its own gravitational force. As it did so, the density increased and star formation accelerated. As the size decreased the rotational velocity increased. The stars, as they formed, decoupled from the gas and remained in what became the galactic halo which, at each stage, was defined by the shape of the collapsing gas cloud, so that the density of stars increased toward the center of the Galaxy. Stars which formed early in the outer parts had rather large random velocities, but as the gas cloud contracted and rotation took over, those formed later in the inner regions had the more orderly circular motions. Meanwhile the gas, which was initially almost pure hydrogen and helium, was becoming enriched by the addition of heavy elements created during the evolution of the stars already formed and returned to the gas through supernovae, so that the younger stars, in the inner halo, were chemically different from the older stars. Finally the remaining gas collapsed into the rotating disk which characterizes the spiral galaxy.

This model explained much of what we knew about the Galaxy, and it still serves well as a begin point for further work. There were, however, some problems. It was hard to account for the motions of some objects in the halo which seemed to be in orbits rotating contrary to the rotation of the system as a whole. Perhaps even more puzzling was the absence of the predicted gradient in chemical composition in the halo. This prompted Searle and Zinn in 1978 to suggest that the halo had formed mainly through the accretion of small companion galaxies. Many such galaxies are known and even more are postulated for the past. There are several striking examples of accretion in external galaxies, one of which being the Spindle Galaxy (NGC2685). In the Milky Way Galaxy itself the recently discovered Sagittarius System, a co-moving collection of stars and globular clusters, appears to be a former dwarf galaxy which is currently being captured by the much larger Galaxy.

M104, the Sombrero Galaxy, with its halo.

Small galaxies and even smaller intergalactic globular clusters could certainly be accreted in this way, and there is no doubt that this process played some role in the formation of the galactic halo. However, the details of the accretion process, and in particular its timing, remain very unclear. This again is largely a question of chemical composition. The companion galaxies and globular clusters which have been studied have a very different composition from the halo stars, being very poor in most heavy elements, and it is very hard to understand how such stars, once in the halo, could have changed their composition. Accounting for the composition of the halo stars sets very strict limits upon the era in which the accretion must have taken place and on the sort of object accreted. It must have taken place very shortly after the formation of the Galaxy itself, and in this short time several large companions must have been accreted, while leaving the Magellanic Clouds undisturbed. After that, very little could have happened, as there are practically no stars in the halo with chemical compositions anything like those found in the small surrounding objects. Accretion of Sagittarius-like dwarf galaxies would be permitted, but such galaxies are scarce in our neighborhood.

Our unsurprising conclusion is that we need far more observations, although these are hard to come by because of the faintness of the objects to be observed. But more importantly, we need to do much more serious thinking about how the galactic halo could possibly have reached the state in which we now observe it.

Planets

Mercury begins the quarter as an evening object, where it will be well placed for observation around the middle of January. It will reappear as a morning object late in February. Although poorly placed for northern observers, it will be within three degrees of Venus until the end of March, making it easy to find. A lunar occultation on March 5 will be visible from southern South America.

Venus, although best placed for southern observers, will be a bright object in the morning sky until late March, when it will start to fade and become lost in the morning twilight. It will be close to Jupiter on the first days of February. There will be a daytime lunar occultation at about noon on March 5, just visible from our region. On the same date there are also occultations of Mercury and Neptune.

Mars, which begins the year just past opposition, will be moving slowly through Taurus, entering Gemini in March and becoming an evening object. It is far north and well placed for observation. A lunar occultation on January 20 will be visible only from the arctic regions.

Jupiter will spend the whole year in Sagittarius. It will become visible in the morning sky during January, and conditions will improve as the months pass. On the morning of March 30 it will be close to the moon, making daylight observation with the unaided eye a possibility.

Saturn will be in Leo for the whole year. It is in opposition on February 24, and is thus visible during most of the night for the whole winter quarter and well placed for observation, particularly for northern observers.

Neptune is close to conjunction so that the monthly lunar occultations, visible in any case only from the southern hemisphere, will not be of much interest.

Meteor Showers

The Quadrantids, one of the major annual showers, is the only shower of note in the winter quarter. The peak, which is of rather short duration, falls on the night of January 3. Observation is possible during the whole night, and the Moon is favorable, being just a few days before new. Besides this, there are two far southern showers later in the quarter, neither of much consequence.

Comets

We were all caught by surprise by the sudden outburst of Comet 17P/Holmes on October 23, when it suddenly brightened from magnitude 17 to magnitude 2.8, an increase of about 500,000 times in only a few hours (see elsewhere in this issue). This comet was so faint and unpromising that it did not make the cut for inclusion in our previous report. Although under the circumstances predictions are very uncertain, it is expected to remain quite will observable for some time. It will remain in Perseus until the end of March.

Comet 8P/Tuttle reaches a maximum brightness of magnitude 6 at the beginning of the year and will remain bright enough for observation for some months. However, after poking around for some time in Cepheus, it suddenly takes off for the southern hemisphere in late December and will disappear from view in the direction of Fornax by early February. By then it will be an evening object.

Comet 46P/Wirtanen, having done its thing in Aquarius, will now head northeast toward Auriga, where it will arrive at the end of March, remaining an evening object. In the meantime it will have passed its maximum brightness, magnitude 8, sometime in February.

Two comets discovered by McNaught from Australia, will start the year too far south for northern observers, but by March, both will be observable from the northern hemisphere, both close to maximum brightness at magnitude 11. Comet C/2006 Q1 will be visible far to the south during the evening hours, moving northward between Pyxis and Antila. Comet C/2007 T1 will be a bit better located, moving northward rapidly between Canis Major and Lepus, decidedly an evening object.

For those wishing entertainment in the morning hours, we can recommend Comet 26P/Grigg-Skjellerup, which has still to reach its maximum brightness at magnitude 12. It will emerge from the morning twilight in February and move from Scorpius into Sagittarius during March.

Finally, Comet P/2003 T12 (SOHO) will become visible in the evening sky during February, and in March, when it reaches its maximum brightness of magnitude 11, it will be moving through Pisces and into Taurus.

Eclipses

An annular eclipse of the sun on February 7 will be visible only from parts of Antarctica, and it is unlikely that many of us will be changing our travel plans on this account.

On the evening of February 20 there will be a total lunar eclipse, most of which will be visible from our area. Only the early stages will have passed before moonrise. The eclipse is not very central, so we may expect to see some illumination of the moon's limb even during totality.

Friends of MIRA Membership

I would like to become a Friend of MIRA and receive the quarterly MIRA Newsletter.

Enclosed is my membership donation of $_______________

In addition, I am making a special contribution of ________

$2500 Associates Circle	$100 Sponsor
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$500 Patron	$35 Member
$250 Sustaining	$15 Student

***MIRA** welcomes corporate and business members. Contributions are tax deductible as allowed by law.*

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City, State, Zip___________________________________

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Welcome to our new Friends

Daniel Fernandez
Liana Lingofelt
Daniel Mathieson

Thanks!

MIRA's Weaver Student Observatory.

Staff

Gordon Jones, Chair, Board of Directors
Dr. Wm. Bruce Weaver, Astronomer & Director
Holly Keifer, Administrator
Dr. Arthur Babcock, Astronomer
Bill Bishop, Volunteer Systems Administrator
Dr. Craig Chester, Astronomer
Dr. Martin Cohen, Astronomer
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Brian Jacobson, Docent
Jim Neeland, Volunteer Systems Administrator
Claas Shane, Librarian
Dr. Whitney Shane, Astronomer & Charles Hitchcock Adams Fellow
Dr. Russell Walker, Astronomer

* * *

The Monterey Institute for Research in Astronomy owns and operates the Oliver Observing Station under permit from the U.S. Dept. of Agriculture-Forest Service.

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The Monterey Institute for Research in Astronomy owns and operates the Richard W. Hamming Astronomy Center and the Ralph Knox Shops through an arrangement with the U.S. Dept. of Education.

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