The Warren Astronomical Society Paper

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The W.A.S.P. is the official publication of the Warren Astronomical Society and is available free to all club members. Requests by other clubs to receive the W.A.S.P. and all other correspondences should be made with the editor at the above address. Articles should be submitted at least one week prior to the general meeting.

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W.A.S.  
Warren Astronomical Society  
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The Warren Astronomical Society is a local, nonprofit organization of amateur astronomers. The Society holds meetings on the first and third Thursdays of each month. The two meeting locations are listed below:

1st Thursday  
8:00 p.m.  
Cranbrook Institute of Science  
500 Lone Pine Road  
Bloomfield Hills, MI

3rd Thursday  
8:00 p.m.  
Macomb County Community College-K Building  
14500 Twelve Mile Road  
Warren, MI

Membership is open to those interested, in astronomy and its related fields. Dues are as follows and include a year's Subscription to Sky and Telescope.

Student  $12.00  
Individual  $20.00  
College  $15.00  
Family  $25.00  
Senior Citizen  $16.00

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Stargate

Lectures are given at Stargate Observatory each weekend. The lecture will be either Friday or Saturday night, depending on the weather and the lecturer's personal schedule. If you cannot lecture on your scheduled weekend, please call the Chairman as early as possible or contact an alternative lecturer. Those wishing to use Stargate must call by 9:00 p.m. on the evening of the observing session. The lecturers for the coming months are:

September 26/27  Frank McCullough  725-4736  
October 3/4  Jim Yax  
October 10/11  Dave Dobrzelweski  979-3273  
October 17/18  Marty Kunz  
October 24/25  Ray Bullock  879-9458  
October 31/November 1  John Root  464-7908

Emergency back-up lecturers:  
Doug Bock  533-0898  
Dennis Jozwik  784-2037  
Don Misson  727-9083
MINUTES OF THE AUGUST 21, 1980 MEETING OF THE WARREN ASTRONOMICAL SOCIETY

The meeting was called to order at 8:25 p.m. by President Frank McCullough.

Nancy Tomczyk reported that the WAS treasury now stands at $156.00.

Mention was made of the summer camp-out to be held September 6 and 7. Members were asked to bring various food items for the picnic to be held Saturday evening.

Pete Kwentus announced that the Toledo Astronomical Association will have a dedication of their new scope on September 27. Those interested in attending should contact Pete for more information.

There was a short discussion of the possibility of hosting a regional convention in May 1982. More on this at future meetings.

Dave Dobrzelewski spoke about a report he has received regarding light pollution.

John Dombrezel spoke about the meteorite that landed behind the garage at his home. It caused a bit of excitement and the event put John on the TV evening news.

Dave Dobrzelewski gave an illustrated slide talk on Saturn. His talk was entitled "The Ring-less Glory" and was very interesting.

Doug Bock showed more slides of his recent trip to Texas and Kitt Peak Arizona.

Ken Wilson, who is visiting from California, showed some very interesting slides he took at Meteor Crater in Arizona and Kitt Peak.

The meeting adjourned at 11:15 p.m.

Respectfully submitted,

Connie Shannon
Secretary
By Brian Klaus

On Wednesday, July 23rd, the path of the Earth’s orbit carried us through the Saturnian ring-plane, crossing from the southern side to the northern, sunlit side of the rings. On the evening of the 23rd and the following two evenings, I viewed Saturn low in the west, around 9:30 p.m., about a half an hour or so after sunset. I was using my six inch Newtonian reflector at 100x and saw no evidence of the rings on those evenings, although at times I was able to see the shadow of the rings on the cloud tops. On the following three evenings the weather and sky conditions did not permit viewing. Finally, on Tuesday, the 29th, I was just barely able to see the rings, a thin, faint line on either side of the planetary disk. On subsequent evenings the rings became more prominent, but I could not see any details because of the poor seeing conditions so close to the horizon, plus the fact that the sky was still relatively bright. Also, the rings are still rather edge-on to us.

On Sunday, July 27th, at 2:52 E.D.T., the Midwest United States experienced an earthquake, measuring over 5.5 on the Richter scale, the epicenter being in northern Kentucky. The tremors weren’t felt in the Detroit area until 2:54 E.D.T. I think it’s interesting to note that exactly 2:54 E.D.T. on July 27th, the full moon occurred. It probably isn’t that strange that an earthquake would occur at the time, of the full or new moon since that is when the tidal forces on the Earth would be at the greatest.

On Monday, August 4th, I observed Venus in the late morning sky, around 10:30, using my six inch at 100x. Having had some experience with seeing Venus in the daytime sky, I was able to estimate the planet's position in relation to the sun, and find it by sweeping with the finder scope. It wasn’t visible to my naked eye, even after I found it in the ‘scope. The disk of Venus was about 40% lit, twenty days before greatest western elongation. I was attempting some astrophotography of Venus, but was limited by time because fair weather cumulus clouds began rolling in, although the rest of the sky was clear.
THE FINE ART OF FILTERING NEBULAE

by Ralph Brown
(Pres.-Livonia Astro. Society)

Around two years ago a unique device suddenly appeared on the astronomical paraphernalia market. It was a magical object which claimed to make faint nebulous objects appear, even in totally light polluted areas. The device was constructed of a thin piece of optical glass coated with certain chemicals which were applied so thinly that they blocked out the particular wave lengths of light that were emitted from street-lights and most other artificial lighting systems. This revelation made it seem that Arizona skies would be available in the vicinity of the RenCen downtown! Although I can assure you that this is not exactly the case, it comes close enough to warrant investigation.

My experience with a nebular filter came last summer when Frank Galea purchased the first that I had the pleasure to use. Certainly Frank has a beautiful home, but as far as good observing is concerned; he may as well live inside a light bulb. However, don't despair for Frank -- these filters were made especially for him and the rest of us who are plagued by similar problems.

The arrival of Frank's nebular filter coincided with the coming of our Club's first-telescope, the 4-1/4" rich field reflector. With the first clear night, Frank and I used a wide field telescope with a nebular filter in hazy, light-polluted skies. Anxiously we aimed the Club 'scope toward the "Dumbbell" nebula (M-27), and immediately failed to see it. Frank then inserted the filter, and lo and behold, there it was, big and bright and showing incredible detail. Needless to say, I resolved to purchase one for myself as soon as possible.

As soon as possible rolled around about two months ago, and I began my research into whether it was worth the $50 I paid for it. At this point I can honestly say that in some respects it has been disappointing, and in other ways it has vastly exceeded expectations. As far as city viewing is concerned, you can definitely see objects that are virtually invisible without the filter. However, the fainter objects still seem to elude even the magic of the filter. Fortunately, in the country, where the Milky Way becomes visible to the naked eye, these filters can produce astonishing effects that could only be described as superb!

My most famous case was observed in the thumb area of Michigan, where the Milky Way appears as a cloud suspended in air and nebulous objects are observed as a matter of course. This object consists of really three faint strands of gases commonly referred to as the Veil Nebula. The Veil is assumed to be the remnants of a super-nova explosion which occurred thousands of years ago in the constellation Cygnus. On this night I had already observed several nebulae with my equipment (a 6" reflector and a 32mm Konig eyepiece with Daystar 300 filter), and wanted to give myself a real challenge while giving the filter an acid test.

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(after next article)
Although I had read in various journals and books that the Veil Nebula can be seen in 7X50 binoculars on a good night," I somehow never really believed that you could actually see it in anything less than a 40 minute exposure with a Schmidt camera.

I remember Lou Faix reporting during a talk that “the Veil” was visible in 7X50's" and I asked "had he ever seen it?"

Well, no he hadn't, with a tone that sounded like "Well, not of course you can't actually see it, but of course it's there as the beautiful photos we've all seen show."

All this got me a bit and I wondered, "Well, can you see it or not?"

Late one Messier observing session at Stargate, Frank McCullough with his 41/4" Coulter RFT with a scotch tape mount quietly reported he had the Veil Nebula in view.

Really? I thought and had a look.

I don't remember which part of the huge Nebula he had in view; but, after careful looking, there it was. My question had been answered. Yes, you can see the Veil Nebula.

But, of course, I wanted to see more. I looked for the Veil, unsuccessfully a number of times after that.

Recently at Stargate I tried again. Using a 6" f/4 RFT (Coulter mirror, assembled from components) and a 24 mm Konig eyepiece (25X), I succeeded.

Looking at 52 cygni, which is easy to find and is crossed by one part of the Veil, I could see an arc of nebulosity curving off the star to the north. To the southeast I could see what was almost a jet of nebulosity streaking off for a degree or so. (This looks like an optical flare of some sort but later observations showed it to be real.)

My RFT brightens faint extended objects, but it also brightens the sky itself, cutting down contrast. And, since the Veil Nebula is a supernova remnant, which is an emission nebula, I used a nebula filter on it (Daystar) and the view was indeed much better.

According to several observing manuals, the part that passes through 52 cygni (NGC 6960) is the fainter half of the Veil, and that the other "half" (NGC 6992) is easier. I did not see NGC 6992 that night, though I looked. The reason I didn’t is that the Veil is so big—I didn’t look far enough.
The huge Veil Nebula is in cygnus. One half of it (NGC 6960) touches the 4th magnitude star 52 cygni which is 3° south of Epsilon. The brighter "half" is about 2¾° ENE of 52 cygni and is a curve over 1° in length. It's the last wisps of a supernova explosion about 30-40 thousand years ago.

This summer at the tip of Michigan's thumb near Caseville, I had another opportunity to observe the Veil. This time in 11X80 and 7X50 binoculars, and yes you can see the Veil Nebula in 7X50's! The skies were (for me) exceptional--the clouds that drifted by were like dark nebulae--no light pollution.

On this occasion I fully observed this enormous and wonderful object. NGC 6992 was obvious, showed good edge definition and shape. It was wider towards the south (like the photos). With the nebula filter, which helped even under excellent sides (the proverbial "skyglow" must be real), there was even a suggestion of structure. I know I must have imagined it, but it really was that impressive.

Even under the best skies I've even seen. 6960 was, however, no more impressive than at Stargate.

There is a north-central part to the Veil which "cannot be detected visually in a small telescope" according to Burnham's. This area shows in photos and on Skalnate Pleso and was not exactly easy, but once seen was obvious in my "small" 11X80's.

All in all, I saw an amazing amount of detail on an object that I had the impression is almost unobservable.

The key to success is seeing the Veil, it seems to me, is to use something which gives you a big exit pupil. 7X50's, 11X80's, a 6" reflector at 25X, or any RFT at low power all qualify. A nebula filter would help too.

--Bob Wilson--

FILTERING NEBULA - continued

While looking at my charts I noticed that a naked-eye star (52 Cygni) seemed to be imbedded in the middle of the western Veil (NGC 6960). So I thought "what the heck ", and aimed right on it. I was never so surprised or overwhelmed since I have had the 'scope! To my utter disbelief I could actually see the Veil Nebula. In fact, upon moving the 'scope around the area, I could see all three parts of one of the most elusive objects available. Before you have me impeached, I have three witnesses who are members of the Club. At an observing site just south of Rockwood, Bill Jolly, Pete Keefe, and Miles Fryer have all seen the Veil Nebula through the above-mentioned equipment, and will (hopefully) testify to my sanity. However, the first glimpse alone up north was certainly worth the price of the filter.

Based on my experience so far, I would have to recommend the purchase of a nebular filter. However, I feel I should prepare you for what else to expect when using one. The filter seems to add contrast to nebula and only discolor and in some cases almost block out stars, which makes it nearly useless for galactic cluster work. Globular clusters, however, are more easily seen (probably due to the sky-darkening effect of the filter), although they are much dimmer than they would normally appear. I have not yet done any galaxy work with my filter, but have been told they are not of much use visually, only for photographic work.

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Thus far, we have explored some of the high points of contribution to, and areas of research in the field of astronomy by the late-eighteenth, early-nineteenth century astronomer, William Herschel. In addition to his work with the sun, moon, planets, telescopes, radiation physics, and asteroids, Herschel can well be regarded as a pioneer in the area of stellar astronomy & variable and double stars, magnitudes and parallax studies, and the resulting catalogues that he published, which for many years were used as standard references in observing.

a. Variable stars

Already, astronomers of Herschel's day had identified many variable stars which showed different characteristics of brightness variation. Some were like the star Beta Persei, or Algol, as it is commonly known, and varied by a few orders of brightness with clock-work regularity. Others, such as Alpha Herculis, were classified as semi-regular, as they varied in brightness in a not-so regular fashion. Yet a third type or variable is virtually unpredictable in its behavior, and these were termed irregular. The star Omicron Ceti, in the constellation Cetus, the Whale, was apparently the first variable star to be recorded, by Fabricius in 1596. Omicron, or "Mira", the Wonderful Star, as it had been called, was fairly regular in its brightness variation like an Algol star, but it varied radically in brightness. At times, it was of the 2nd magnitude, and then was observed to fade entirely from naked-eye visibility, to around 9th mag.!

Herschel undertook regular watch of Mira in his early astronomical days from 1777 to 1780, and his observations appear consistent with the accepted period today of 312 days, while his later observations point closer to 331 days. Herschel reported his observations of Omicron Ceti to the Bath Society in 1781, and to the Royal ten years later, in 1791.

Herschel developed a novel technique for discovering stellar variables, as will be elaborated on in the section on stellar magnitudes. In applying his procedure, he discovered the variability of Alpha Herculis, and thus "bridged the gap" between the short period variables like Algol (period 69 hours) and the long period types like Mira. (312 days). Alpha is a semi-regular with a period on the order of 90 days. He thus felt inclined to bring all variable stars into a single class of spotted, rotating globes, and he felt from his solar observations, that the sun could be classified as a typical member of them.

b. Stellar magnitudes

One of Herschel's chief interests lay in the problem of classifying the brightness of stars in general. Not many standard catalogues of stars existed then, but Herschel noted from those which were available (most notably, Flamsteed's) that many stars appeared to have suffered changes in brightness in the preceding 200 year period. In fact, of his 3,000 differing magnitude observations, he had shown over 100 stars to be of magnitudes than those listed in the standard sources of earlier epochs. Herschel correctly believed that, in addition to the several observed variable stars, still more changed very slowly and/or by an amount too slight to strike the usual observer. His surmise of the situation was interesting and meritorious; he believed that the discovery and subsequent observation of such "suspect" stars was of more than academic interest, but that they could lead to a better understanding of our own sun, which itself was suspect of being variable in its energy output. He considered such variability in brightness to be responsible for some of the climates' changes on the Earth and evident changes in life-forms and species. Equipped with a better understanding of the variability of said stars can result in man's better ability to estimate and possibly predict the waxing and waning of the sun as they affect the Earth.
Herschel believed also that all stars, taken as a whole, describe essentially a standard of brightness and intensity. This is one of the convictions that Herschel held that modern science is at odds with, along with the idea of a dark sun and living creatures on the moon and Venus, etc. However, it must be noted, that he was acutely innovative and these ideas are the very ones which led man on the scientific road we travel today—to verify or disprove these notions, and thence know the truth of the matter! Getting back to the Herschelian hypothesis of uniformity in stellar intensity, he also postulated a uniformity in stellar distribution. While the 'shape of the heavens' can itself be irregular or of a definite form, symmetrical or otherwise, the stars within are strewn with random uniformity. In this way, he accounted for the small number of first-mag. stars, and the increasing number of fainter stars, until the stars barely detectable in great telescopes are of a countless abundance. The bright stars fill a comparatively small imaginary sphere about the Earth, and fainter and fainter stars fill increasingly greater volumous imaginary spheres, thus allowing for greater numbers. And of course, being that stars are approximately equal in brightness, at these great distances, they appear increasingly faint. While his notion sounds entirely legitimate and plausible on the surface, we know today that stars do not describe even a roughly accurate constant of brightness or of size for that matter, but most of the brightest stars seen from Earth are in fact among the most distant, and thus the most luminous. At the same time, most of our nearest stellar neighbors are very faint; some so much so that a giant observatory telescope is required to even detect their feeble light. Some of Herschel's Society colleagues were inclined to hold reservations about his ideas, but Herschel argued that stars, like human beings and oak trees all describe a fairly uniform standard of attributes.

In his studies of stellar magnitudes, Herschel arranged the visible stars in the various constellations according to their apparent order brightness in ascending or descending order. In that way, any future changes in any particular star's magnitude will reveal itself in a disruption of the sequence. Using this procedure, Herschel observed over 3,000 stars. E.C. Pickering, 100 years later, said that Herschel's star catalogues had magnitudes with an accuracy equal to that obtainable in his day, and were utilized by astronomers as a standard reference!

c. Stellar Parallax

One of Herschel's early endeavors in astronomy was one which man began pondering only 1½ centuries earlier: stellar parallax. Galileo Galilei, in his "Dialogo" of 1632, the Third Day, suggested that the revolution of the Earth around the sun might be proven through the observation of stars relative to each other in the sky. A star's position would shift relative to more distant ones in the course of the Earth's traverse about the sun, and the measurement of this paralactic shift, or parallax, would be a direct mathematical measure of the star's distance.

Herschel wanted to continue the efforts of his predecessors, namely James Bradley, who attempted to measure the annual stellar parallax of various stars, but had been unsuccessful. In a paper to the Society, Herschel proposed a new method of measuring the elusively small shift of the stars: using double stars. He felt it was an irresistible opportunity to put his stellar brightness hypothesis to work, where the pairs of unequal brightness were close enough to each other that a relative shift of the brighter member (and hence, the nearer) against the fainter and more distant one would be measurable. Herschel obviously contended that double stars were really a phenomenon of two or more star very much distant from one another, but almost together in our line of sight*. The idea would be to use double stars of greatest difference in magnitude between the members (or 'comes', as they are referred to by double star observers) as comes of nearly equal magnitude are likely to be near each other, thus they would share a relatively common paralactic shift. Herschel was unknowledgeable to the fact that only rarely do two stars actually coincide in position in the sky, as the observer F.G.W. Struve in Germany (my hero!!) was to later to inform John Herschel, when the elder Herschel's son was himself an astronomer. When Herschel set out to measure parallaxes, three measures of the pairs were taken: one on either side of the Earth's orbit (thus, six months apart) and then a third at the starting point again to account for proper motion,
and if any measured, would be figured into the second measure taken six months earlier. It was difficult enough to measure some of the pairs, as virtually all ranged in seconds of arc separation, and in fractions thereof. And while Herschel's efforts were novel at obtaining stellar parallax, he was to be no more successful than his predecessors. Parallax would remain unmeasured until 16 years after his death. Typical parallaxes run in the area of 0.001" arc, so that even a close double would not be sufficient!

*Some double stars are in fact merely in a happenstance line-of-sight alignment, called 'optical doubles'. But today, we know that the vast majority of doubles are true pairs of stars in gravitational association with one another. Close, chance alignments do happen, but are quite rare, indeed!*

d. Double Stars

Herschel set out on the problem of parallax, as we have seen, by measuring double stars. This entailed the determination of two characteristics of a given double star:

1) separation of the comes, in seconds of an arc, and
2) position angle of line containing both comes, relative to north, measured in degrees (360 all around)

Herschel composed a large-scale catalogue of double stars he himself measured, and added a second installment later in life to the work. He set out to survey the sky, observing all the stars listed in the Flamsteed catalog, and find as many doubles as he could with his 7-foot, 4½ inch, and 7-foot, 6.2 inch reflectors. One fellow member of the Royal Society, John Michell, argued that the double stars were too numerous to regard them all as being chance alignments in the heavens. Michell hypothesized that many, if not most, were actually physical systems which were gravitationally bound in a common orbit in space. Herschel cautiously advised Michell that it may be too early to conjecture any theories on the nature of double stars.

However, over the quarter century that followed, Herschel carried out a pain-staking measurement of around 50 doubles, and had shown that most of them appeared to describe exclusive orbits about one another or, in the case of a pair of very different magnitudes, the fainter about the brighter. And about that time, Struve back in Germany had begun his famed double star work, and in 1832, issued to John Herschel, and the astronomical community as a whole his calculated orbit for a close pair he had been measuring, with an assigned period of 42 years.

Nonetheless, while Herschel’s original intent of making a double star catalog to be used as a parallax reference did realize, he did begin a study in astronomy of observing and measuring double stars and ultimately a study of their gravitational and related physical characteristics for generations to come.

For our fifth and final look at Herschelian astronomy, we shall now turn to the area I have called ‘Prototype Cosmology’. Herschel observed thousands of nebulae and what we call ‘deep-sky wonders’ today, and with them, made catalogs, more papers to the Society, and began piecing together a model of the Sidereal System, or the Universe as Herschel and his contemporaries knew it. Next, in “William Herschel: Prototype Cosmology”.

November will be an exciting month for both amateur and professional astronomers alike when Voyager 1 passes only 124,200 kilometers (71,174 miles) from the planet Saturn. This report, prepared by the Jet Propulsion Laboratory of Pasadena, California, will be in two parts: the first will discuss the science rationale of the Voyager 1 Saturn mission and the second will examine the day-to-day itinerary of the close approach... Part two will be presented next month.

SCIENCE RATIONALE

Saturn is one of the four outer planets or gas giants of the solar system, Jupiter is largest, closest to Earth, and the prototype of these planets that include Uranus and Neptune. While all four are similar on a gross scale—huge accumulations of hydrogen and helium with small, rocky cores—each exhibits significant differences.

One key difference between Jupiter and Saturn—one that Voyager 1 will pay special attention to—is the mechanism for interior heat generation. Both Jupiter and Saturn radiate about twice the energy they receive from the Sun. Jupiter's heat has been escaping for 4.6 billion years, since the solar system formed, and was generated by gravitational contraction left over from the formation of the solar system 4.6 billion years ago.

Theoreticians find that Saturn should have cooled off to equilibrium (intake equals output) long ago. Therefore theory says that the current surplus heat may be caused by some other mechanism, such as separation of hydrogen and helium, with the heavier helium sinking toward the center. But there may be other possible explanations.

The science to be performed by Voyager 1 at Saturn is divided into four categories:

*The planet;
*The rings;
*The satellites, with emphasis on Titan;
*The magnetosphere.

Saturn and its satellites are too far from Earth to be studied as thoroughly and in as high resolution as Jupiter; they are twice as far away from Earth, and the satellites are only point-sources in a telescope. (Astronomers are able to resolve the disks of the large Jupiter satellites in telescopes.)

*Saturn: Since Saturn is so far from the Sun, it is colder than Jupiter. Material in its atmosphere freezes at greater depths than on Jupiter. Ammonia, for example, freezes and forms clouds on Saturn at a depth of two or three Earth atmospheres, instead at one atmosphere as on Jupiter.

Saturn displays fewer atmospheric features (and they appear more subtle) than Jupiter's features. That is attributed to high-altitude atmospheric haze on Saturn that obscures the clouds.
Astronomers have determined that the velocity or winds at Saturn's cloud tops is about twice that at Jupiter. Calculations show that the wind to be about 1,400 kilometers (900 miles) an hour. The calculations are based on observations from Earth, of spots in Saturn's clouds, combined with Voyager's radio measurements of the rotation of the interior of Saturn.

Voyager scientists want to understand the atmosphere in terms of:

a. Its over-all structure and composition—how it is put together, what it is made of, and fine scale (or very small) differences:

b. Differences between bright zones and dark belts:

c. How material in Saturn’s atmosphere changes with depth in the atmosphere;

b. Size, density and composition of the core. (the core is thought to be about the size of the Earth, but to have about 15 to 20 times the Earth’s mass.)

*Rings: The rings’ designations were assigned chronologically, and so have nothing to do with relative positions. This summary will list them beginning with the outermost ring.

E-ring: extending to about eight Saturn radii (480,000 kilometers or 298,000 miles) from the planet. It has been photographed from Earth.

F-ring: identified in images taken by Pioneer 11. It is a very narrow ring just outside the A-ring, but distinct and separate from the E-ring.

A-ring: outermost ring visible with small telescopes.

B-ring: the brightest ring, lies inside the A-ring, and is separated from it by Cassini's Division. The Division is not clear of material, but has a small amount of material in it. From Earth the B-ring appears completely filled with material; a few Pioneer 11 images, however, show light leaking through, leading to speculation there may be holes in the ring.

C-ring: (Crepe-ring) barely visible in small telescopes, it lies inside the B-ring.

A D-ring has been claimed between the C-ring and the cloud tops. Some scientists doubt its existence.

Observations in 1966 yielded ring thicknesses of one to three kilometers (.62 to 2 miles) thick, although recent analysis suggests that the rings may be thicker.

The rings appear to be entirely ice-covered material from a few centimeters to a few meters in diameter. Scientists want to determine the particle sizes and densities, and if other material is present. How and why the rings formed is also a major question. The manner in which sunlight is scattered by the material depends on the area and size of the particles, and their numbers. Particles several times the wavelength of light will be visible mainly by normal scattering. The normal scattering properties of ring particles depend primarily on area and color of the individual particles. Jupiter's ring foreword scatters because it contains particles about 0.0006 centimeters (0.0002 inches) in diameter. Saturn's rings backscatter strongly.
Foreword scattering has not been observed, simply because the opportunity has never arisen.

Radio signals sent by the spacecraft through the rings to Earth will be used to help answer the size question; they will identify size ranges. (Photos probably will not resolve individual particles.) The radio signals, operating on the same principal of strong foreword scattering as light, will identity particles 30 to 100 centimeters (1 to 3 feet) in diameter. Measurements of the signals’ attenuation by the rings will give information on particles that are larger than a few centimeters.

Scientists want to determine why density apparently differs from ring to ring, and if there are waves within the rings. Waves may be set up in the ring material by gravitational forces from satellites outside the rings. Large objects in the rings themselves may also cause local variations in ring-particle density.

*Satellites: The satellites, with the exception of Titan which is in a class by itself, are different from any others in the solar system. Titan is the largest satellite in the solar system, and the only one known to have a substantial atmosphere. Uncertainties in the determination of its size are great enough that Titan could have a diameter anywhere from 5 per cent to 20 per cent larger than Mercury, and could either be all ice, or could be made of ice mixed with as much as 15 per cent rock. Scientists hope to photograph the surface if the atmosphere is clear enough, but existing evidence indicates it will not be. Titan’s atmospheric pressure is now estimated to be between 20 millibars and 2,000 millibars at the surface. (Earth’s surface atmospheric pressure is about 1,000 millibars; Mars' atmospheric pressure is about 10 millibars.)

The other satellites fall into a new size class by themselves. Jupiter's Galilean satellites are larger; Jupiter's Amalthea, and the tiny Martian satellites Phobos and Deimos, are smaller. Uncertainties about densities of all the Saturnian satellites are great enough that they could range from ice bodies to mixtures of ice and rock, with the rock up to 20 per cent. It now appears that Voyager may discover a number of new, small satellites outside the A-ring.

*Magnetosphere: Why does Saturn's magnetosphere behave so much differently from the magnetosphere of Earth and Jupiter? Pioneer data show that Saturn's magnetosphere is smaller and more regular than Jupiter's. Of interest to scientists is that Saturn's magnetic pole is offset by less than one degree from the rotational pole. The magnetic poles of Earth, Jupiter and the Sun are offset substantially.

*Voyager has already determined with high precision the length of day on Saturn: 10 hours, 39.4 minutes. This rotation period refers to the bulk of Saturn and was determined from radio-astronomy data
obtained since January 1980. Earth observations had shown similar periods for temperate and polar regions of Saturn, but a much shorter (10 hours, 14 minutes) period near the equator, indicating the presence of a high-velocity equatorial jet stream.

Data from all the experiments--10 instruments and the spacecraft radio combine synergistically. While single instruments determine specific quantities—for example, the IRIS makes temperature and composition measurements—it is by combining data from several instruments that the science teams will assemble a coherent picture of the entire Saturn system.

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ABRAMS PLANETARIUM
SKY CALENDAR SEPTEMBER 1980
Information for helping teachers and students observe the sky

SUNDAY

Venus 18° south of the Moon on Sept. 5, and 11° south of the Moon on Sept. 10. Venus is 9° east of Spica Sept. 5, 1° east of Spica Sept. 10.

On Fri Sept 5 Venus will be very close to the Moon as they rise about 3½ hours before sunrise. Observers in eastern U.S. can see near miss.

Morning: 7 Regulus 30° Venus
7 Regulus 30° Venus

On Sept. 5 Regulus is 30° to the south of Venus.

MONDAY

Moon occults Gamma 1 Tauri in predawn from western U.S.; Central Cal Pleiades 3:4 am PDT; Denver 4:24-5:19 am PDT.

Morning: 6 Aldebaran Quartet in morning sky.

TUESDAY

Pleiades 9 Regulus 30° Venus

WEDNESDAY

Zubenekuni, Alpha in Libra (d Libra) 3:00 am PDT, not visible today. On Sept. 6, 7, and 8 Alpha in Libra is visible.

THURSDAY

Friday: Spectacular conjunction! Look very early. See note left of Sept. 1.

SATURDAY

Venus will pass very close to Regulus 4 weeks from today.

Coming into Libra this month is the constellation of Virgo, which includes the bright stars of Spica and Aldebaran.

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Subscription: $2.00 per year, from Abrams Planetarium
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The chart is drawn for Latitude 40° north, but should be useful to stargazers throughout the continental United States. It represents the sky at the following local daylight times:

- Late August 11 p.m.
- Early September 10 p.m.
- Late September 9 p.m.

This map is applicable one hour either side of the above times. A more detailed chart by George Lovi appears monthly in the publication Sky and Telescope.

The planets are not plotted on this map. Check the Sky Calendar for planet visibilities. At chart time 7 objects of first magnitude or brighter are visible. In order of brightness they are: Arcturus, Vega, Capella, Altair, Antares, Fomalhaut, and Deneb.

In addition to stars, other objects that should be visible to the unaided eye are labeled on the map. The double star (Dbl) at the bend of the handle of the Big Dipper is easily detected. Much more difficult is the double star near Vega in Lyra. An open or galactic star cluster (OCl) located below Sagittarius, low in the south-southwest, will challenge the unaided eye. Nearby, marked Nb above the "spout" of the "Teapot," is the Lagoon Nebula, a cloud of gas and dust out of which stars are forming. The position of an external star system, called the Andromeda Galaxy after the constellation in which it appears, is also indicated (Giz). Try to observe these objects with unaided eye and binoculars.

—D. David Batch