



# EPHEMERIS

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FEBRUARY 1990

## FIELD OF VIEW

- JOHN GLEASON

We are pleased to have as our speaker this month Joe Wujek of the Lowell Observatory Advisory Board. Joe's subject will be "Of Percival Lowell, Martian Canals, and an Arizona Observatory". Just before Joe's talk we will be holding the annual elections for the Board of Directors.

Other events this month include a public star party February 2nd at Branham lane park, (weather permitting), monthly Board Meeting on February 10th, and two star parties to finish out the month. The first one on February 17 at Grant Ranch, the second on February 24th at Henry Coe park.

## ELECTIONS

The February meeting of each year is designated the "Annual Meeting", at which the Board of Directors is elected. Continuing for another year are: Steve Greenberg, Jim Van Nuland, Tom Ahl, Brian Munro, and Paul Mancuso. Four members will be elected or re-elected. Candidates: Brian Zehring, Jack Peterson, Gene Cisneros (all returning), and Wolfgang Hanish (new).

The officers will be elected from the newly-constituted board at the Feb. 10 Board Meeting to serve one-year terms.

## PHOTOGRAPHER AT LARGE

If you have been enjoying the photography in recent issues of the Ephemeris, then you have Robert Keller to thank. Bob can usually be found at most General Meetings and Astronomy Classes taking a few snaps of our activities. Smile, and don't be camera shy. You too can be among the *Rich & Famous* whose portraits have appeared on these pages. Thanks Bob, and keep up the good work!

## BRANHAM LANE STAR PARTIES

Don't forget that the SJAA is holding public star parties on the following Fridays. Here are the upcoming dates:

February 2, March 2, April 6, May 4, June 1, June 29, July 27, August 31, September 28, October 26, December 28. Bring a telescope and tell your friends. For more information please contact Tom Ahl or Jim Van Nuland. Their telephone numbers are listed elsewhere in this issue.

## FEBRUARY STARRY NIGHTS

- RICHARD STANTON

**METEORS** - The only meteor shower coming to maximum during February will be the **Delta Leonids**. This is a minor event that will achieve maximum on February 26th with a two day old moon, so the sky should be nice and dark.

## FEBRUARY METEOR SUMMARY FEB 26 - DELTA LEONIDS - MINOR

**GALILEAN SATELLITES** - The two optimum observing Saturday nights for this month are February 17th and February 24th with the Moon staying out of the night sky until after midnight. Only the evening of Saturday the 17th will be showing Galilean events before most of us have trodded off to find our jammies and blankies. However, it will be a busy evening for our Jupiter observers.

**FEB 17 - 20:10 hr - Callisto - Occ. Dis.**  
21:14 hr - Io - Trans. Ing.  
21:57 hr - Callisto - Occ. Reap.  
22:19 hr - Io - Shad. Ing.  
23:27 hr - Io - Trans. Egr.  
**FEB 18 - 00:33 hr - Io - Shad. Egr.**

**FEBRUARY DEEPSKY CHALLENGE** - This one is really not too difficult at magnitude 12. The Helix Galaxy, also known as NGC 2685. This is a pretty faint, round to elongated galaxy. It's somewhat brighter toward the center with a diffuse halo. It can be found at R.A. 08hr 55min, Dec. +58 deg, on the boarder of Ursa Major and Lynx. As I didn't drag my charts out, I can't tell you whether it's officially in Ursa Major or Lynx, perhaps you'd like to check it out.

**ENCYCLOPEDIA GALACTICA** - One of the things that I do to avoid doing all the chores I'm

supposed to do by doing is to rummage through my library ... explaining to my wife that there is no higher activity for the human soul. Sounds good to me. The fun part of this is that sometimes I stumble on an item of astronomical curiosity. The following are two Moon related superstitions for which I cannot find the origin but they are nonetheless nifty superstitions whether they hold true or not. The first is, "If you make a wish on a new moon, your wish will come true.", and the second is, "Turn you money over when you first see a new moon and it will bring you more money". I'll give you one

## FEBRUARY 3RD ANNUAL MEETING ELECTIONS JOE WUJEK

**FEBRUARY 2: (FRIDAY) PUBLIC STAR PARTY AT BRANHAM LANE PARK. STARTS AT DUSK**

**FEBRUARY 3: ANNUAL MEETING! BOARD ELECTIONS FOLLOWED BY JOE WUJEK - LOWELL OBSERVATORY**

**FEBRUARY 10: SJAA BOARD MEETING AT 6:30 PM. INTRODUCTORY ASTRONOMY CLASS AT 8:00 PM.**

**FEBRUARY 17: SJAA STAR PARTY AT GRANT RANCH COUNTY PARK. DUSK TILL FROZEN.**

**FEBRUARY 24: STAR PARTY AT HENRY COE STATE PARK. DUSK TILL FROZEN.**

**MARCH 2: (FRIDAY) PUBLIC STAR PARTY AT BRANHAM LANE PARK. STARTS AT SUNSET.**

**MARCH 3: GENERAL MEETING, 8 PM. SPEAKER TO BE ANNOUNCED!**

**MARCH 10: SJAA BOARD MEETING AT THE RED CROSS, 6:30 PM, FOLLOWED BY THE INTRODUCTORY OBSERVATIONAL ASTRONOMY CLASS, 8 PM.**

**MARCH 17: STAR PARTY AT GRANT RANCH COUNTY PARK. DUSK TILL DAWN.**

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guess who's going to try them out this month. If I can figure out how one "sees" a new moon with the naked eye. If any of you know the answer, share it with us. Good Observing Until Next Time!

*(Richard, the answer to your question is simple. A new moon is quite easily visible during a TOTAL SOLAR ECLIPSE! - ED.)*

## COLLIMATION, THE ETERNAL QUEST

- STEVE WALDEE

### PART ONE: NEWTONIAN NUGGETS

Not being an astrophotographer, I have long envied the incredible skill, patience, and determination of astronomers who can stare into a guiding eyepiece for up to a full hour while making miniscule tracking corrections so that their photos of faint galaxies are crisp, clear, and free from bloated and trailed star images.

As a mere visual observer, I longed for some excuse to eternally fuss over my equipment and to be drawn into a monomaniacal pursuit of optical perfection, and frankly for a reason to get out of my wife's way and into the garage during the daytime so that she can teach piano students in peace, free from my meddling and banging around in the kitchen!

I am happy to report that I now have an astronomical pursuit that seems to be as consuming a hobby as observing itself: *eternal collimation*. For if one owns reflecting telescopes, the task is never done, and we travel the endless asymptote, approaching but not quite reaching the goal.

Three of my four telescopes are quite willing to have their screws and sliders endlessly tweaked, with only my Astroscan as wary of adjustments, or I would have been glad to devote a few hundred hours to its ministrations. For unless optical alignment is merely perfect, you can forget about splitting 1-arcsecond doubles or looking for tiny white ovals on Jupiter's belts.

After blundering my way through collimation for ten years, I decided to *Get Serious* about it last summer, and started by making a sighting tube by removing the lenses from a useless old 5mm Ramsden eyepiece. The tiny two-millimeter hole for the eye lens made it easy to position my head properly over the focuser to see if the diagonal mirror was fully illuminated. But my star images were still astigmatic, and focus was vague and broad in my more-or-less homemade 10" f/5.6 Newtonian.

The next step was to remove the primary mirror and paint on a 3/8" dot in the exact center. When the scope was reassembled, I could put up the reflection of the dot right in the center of the diagonal, and obtained exceptionally improved images. Of course, the diagonal casts a shadow over this area of the primary mirror, and absolutely no light is diminished.

But my appetite for perfect collimation had only been whetted. I could jestingly say that if the double star was no further separated than Mizar and Alcor, my scope would now split it! I thought I needed better precision than my rudimentary methods would provide.

The Tectron Collimator provided weeks of optical ecstasy, driving my collimation fever to new heights of frenzy. This \$95 gadget consists of three custom eyepieces (a sight tube with cross hairs for coarse positioning, an imaginative Cheshire eyepiece with diagonal mirror illuminator, and the unforgiving Auto-Collimator eyepiece for the ultimate in alignment fastidiousness.) Completing the package is a manual that will keep you entertained indoors on cloudy evenings, deciphering its philosophical meanderings and abstruse instructions. Rather than just telling simply how to use the thing, the book delights in walking you leisurely through the Theory of Collimation, on a quantum-mechanical level of abstraction. It brought back fond memories of 8th-grade New Math ("Just tell me how to DO the  $X@\$*\&\%$  logarithm!") I would mutter under my breath, while wading through chapters of Cartesian philosophy.)

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*"For life is short, but Collimation is eternal."*

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The Tectron kit sends you down the pathway toward perfect alignment, enabling proper placement of the diagonal within the light cone, axial alignment of the mirrors with the eyepiece, and diagonal plus the problems in focuser placement or skew. The incredibly sensitive auto-collimator eyepiece with its round perforated mirror just behind the eye opening, will only light up with illumination from the primary mirror when the system is virtually perfect: even tightening or loosening the eyepiece clamping screw on the focuser will extinguish the reflection, demonstrating how crude our equipment is compared to the tiny wavelengths of light.

I had spent so many anxious hours perfecting my homebrew collimation techniques prior to obtaining the Tectron that I was slightly disappointed to discover that I had gotten quite close

to near-perfect alignment without it. But at least the instrument finally proved that my problem was in a faulty diagonal mirror, and not wretched collimation. When I installed my new (and smaller) diagonal, the Tectron enabled quick and foolproof daytime alignment in minutes, and at least close doubles and the 5th and 6th members of the Trapezium were clear and crisp!

In my next installment, I'll recount the agonies of night-time alignment on star images, and in Part 3, the delicious horrors of adjusting Schmidt-Cassegrains.

## THE CELESTIAL TOURIST SPEAKS

- JAY REYNOLDS FREEMAN

One of the fun things about amateur astronomy is the heated arguments about telescopes. I've heard a lot of these recently and have participated in most of them. In particular, there has been a lot of fuss about kind, size and quality of telescope objectives - what's best, who makes good stuff, what kind of performance should we expect, and what kind do we really get. I thought a bit of technical discussion might be worthwhile. I shall promulgate and discuss two rules about telescope objectives:

- (1) Aperture is not substitute for optical quality.
- (2) Optical quality is no substitute for aperture.

If you are now confused, you are in good company: So is most everybody else. These rules are not contradictory, they merely stem from the fact that we use our telescopes for two different kinds of things. We use them to see fine detail, and we use them to see faint objects.

One aspect of the second rule is obvious. The amount of light a telescope gathers is limited by the size of the objective. No amount of optical perfection can increase the rate at which photons from a distant object fall on a circle of a given diameter.

My 90mm fluorite refractor (Celestron SP-90F) has an unobstructed objective, fully-coated everything, near-perfect optics, good internal baffling and suitably steady mount. It's within sneezing distance of theoretical perfection. But it is still only a 90mm telescope. Even with a generous allowances for light lost in multiple reflections and blocked by the secondary, my 8-inch Dobson-mounted Newtonian gathers more than three times as much light as the fluorite and my Celestron 14 collects over eight times as much. The difference is obvious when looking at deep-sky objects: I can detect

Stefan's quintet with the 90mm, but the group is easy in the 8-inch, and the 14 begins to show structural details in each of the galaxies. Truly lousy optics, inadequate internal baffling or phenomenally bad seeing could restrict the ability of the larger telescopes to observe faint objects, but such cases are thankfully rare: By and large, the big telescopes are a clear win for looking at lumpy darkness.

Aperture limits telescope performance in another way, but here we must begin to talk seriously about optical quality and telescope design. With perfect optics and perfect seeing, the diameter of the Airy disc - the central part of the image of the star under high magnification - decreases in inverse proportion to the diameter of the objective. With perfect seeing and perfect optics, an eight-inch telescope of given design should resolve double stars whose components are of equal brightness, down to a separation only half that possible in a four-inch telescope of the same design.

All the qualifiers in the last sentence are necessary. We all know that bad seeing can obscure detail, and most of us know that large telescopes are often more affected by seeing than small ones. But not everyone understands that some details of telescope design also affect resolving power.

The best-known design detail that affects resolving power is the spider arms that support the secondary of diagonal in most Newtonians and in some other telescopes. We have all seen "spider spikes" around bright stars. If you are looking at a double star with a faint companion that happens to lie directly under such a spike, you may not be able to see it, even if the separation is extremely wide. It should also be clear that the cumulative effect of all the spikes reduces contrast in lunar and planetary detail. For the record, thin spider arms put less total light into their spikes than do thick ones.

Secondary mirrors and diagonals affect resolving power whether they are supported on spiders or not: The Schmidt-Cassegrains and Maksutovs from Celestron, Meade, and Questar all have secondary spots (including baffle) that are roughly one third the diameter of their respective correcting lenses (the Meade LX-6's is even larger). With otherwise perfect optics, such a spot approximately doubles the amount of light in the diffraction rings that surround the central Airy disc in the image of a bright star. With no spot, approximately 82 percent of the light goes into the central disc and 18 percent into the rings; with a one-third diameter spot the proportions are more like two to one. Furthermore, the spot makes the ring structure "broader" - successive rings out from the disc are not nearly as faint as with an unobstructed

aperture. These wide, bright rings again reduce the contrast of lunar and planetary detail.

The secondary spot does bring one benefit to resolving power: It shrinks the diameter of the Airy disc a little, thereby increasing the telescope's performance on double stars whose components are of similar brightness.

Let's take a specific example. Suppose we found a Celestron C-90 Maksutov telescope which happened to have excellent optics, and compared it with my 90mm fluorite. The C-90 has a one-third diameter central spot, so it has wide, bright diffraction rings, so its ability to detect subtle planetary detail should suffer in comparison to the fluorite. On the other hand, the Maksutov will be producing Airy discs slightly smaller than those of the refractor, so the former instrument should do better on double stars with components of similar brightness than the latter.

Finally, there is a piece of folklore that bears mentioning. I keep hearing that vacuum-deposited metal coatings, such as those used to aluminize telescope mirrors, scatter light. To the extent that that is true, any telescope that uses mirrors anywhere in its optical path - whether in primary, secondary, Newtonian diagonal or star diagonal - will suffer loss of contrast in its images. I have never seen any data to confirm or deny this rumor, and I am puzzled why not. The presence or absence of such scattering should be a matter of great concern to people who work with very high light intensities - for example, with big lasers - and the phenomenon should be easy to measure in a reasonably-equipped laboratory. I'd be obliged if anyone could point me at any published measurements on the subject.

So much for design, now let's talk about optical quality. Clearly, there is no telescope with so much aperture that its performance cannot be ruined by bad optics. Furthermore, some sad facts of optical engineering interact in such a way as to make medium and large amateur telescopes more likely to have bad optics than small ones.

How come? Well, most of the small telescopes that we amateurs use - say, up through four-inch aperture - are either refractors or Maksutovs. The surfaces of the lenses, corrector plates and mirrors in these instruments are generally spherical, and it turns out that spherical optics are especially easy to make. Thus, with a little attention to quality control, a manufacturer can produce good small refractors or Maksutovs at a reasonable price. (I don't say they all do, only that it is possible.)

What's more, the Airy discs produced by per-

fect small telescopes are intrinsically larger than those produced by perfect big telescopes. Thus the optical tolerances for high-quality small telescopes are sloppier than for big ones. The small Airy disc of a large telescope is a tougher mark to shoot for. It's like Alice in Wonderland, manufacturers of big telescopes must run twice as hard just to stay in the same place.

Few of us can afford big refractors, and those who can find the long tubes hard to carry around. Big Maksutovs are more portable but almost as expensive, and their thick optical-glass correctors can take most of the night to come to thermal equilibrium and begin to perform. Most of the medium and large telescopes we use are Schmidt-Cassegrains and Newtonians.

These latter designs do not use all-spherical optics, and aspheric surfaces are hard to make. The paraboloidal primaries of Newtonians require much hand-figuring. The corrector plates of Schmidt-Cassegrains are made by a clever process that makes it easier to produce pretty good ones, but the results are not perfect, and require careful mix-and-match selection of components and perhaps hand-figuring of the secondary. All this is hard to do well - that is, it's expensive.

Furthermore, in the interests of portability, the larger Newtonians that amateurs use generally have to be "fast" systems, with focal lengths only four or five times their apertures. Fast paraboloids are vastly more aspheric than slow ones, and thereby are vastly more difficult to manufacture. It can be done, but it is time-consuming and expensive to do it well.

Thus the odds are reduced, that large amateur telescopes of the kinds we use most often, at the prices we like to pay, will have excellent optics.

## SPACE PROGRAM UPDATE

- BOB FINGERHUT

### PLANNED EVENTS IN THE U.S. 1990 SPACE PROGRAM

**Feb. 1** - Launch of the shuttle Atlantis - Classified Military Payload.

**Feb. 9** - Galileo spacecraft flies past Venus.

**Mar. 26** - Launch of shuttle Discovery with Hubble Space Telescope.

**Apr. 26** - Launch of shuttle Columbia with Astro-1 space lab.

**Jun. 4** - Launch of shuttle Atlantis with Gamma Ray Observatory.

**Jul. 9** - Launch of shuttle Discovery - Classified Military Payload.

**Aug. 10** - Magellan Spacecraft arrives in orbit around Venus.

**Aug. 16** - Launch of shuttle Columbia with Life Science Spacelab laboratory.

**Oct. 5** - Launch of shuttle Atlantis with Ulysses Solar Probe.

**Nov. 1** - Launch of shuttle Discovery with SDI experiments.

**Dec. 6** - Launch of shuttle Columbia with Microgravity Spacelab.

**Dec. 8** - Galileo spacecraft makes first pass by Earth.

#### **PLANNED EUROPEAN ARIANE LAUNCH SCHEDULE FOR 1990**

**Jan.** - French SPOT remote sensing satellite.

**Mar.** - French TDF2 and German FDS Kopernikus 2 satellites.

**Apr.** - European Eutelsat 2A and Eumetsat MOP2 satellites.

**May.** - British Skynet 4c and GTE Spacenet G-Star 4 satellites.

**Jun.** - Hughs SBS-6 and Galaxy 6 satellites.

**Sep.** - Eutelsat 2B and Italy's Italsat 1 satellites.

**Oct.** - European ERS-1 Earth Resource Satellite.

**Nov.** - GE American Satcom K3 and Inmarsat 2F3 satellites.

**Dec.** - Canada's Anik E1 satellite.

#### **FIRST COMMERCIAL TITAN FLIGHT LAUNCHED NEW YEAR'S EVE**

Martin Marietta became the second company to enter the commercial launch market with its launch of two communication satellites on its Titan booster. Three more customers have signed up for Titan launches. McDonnell Douglas made the first commercial launch with its Delta booster last August. General Dynamics will enter the commercial market this summer when they launch NASA's combined release and radiation effects satellite on an Atlas booster.

#### **JAPANESE SPACE PROGRAM INCLUDES LUNAR MISSIONS**

Japan's plans include a dual satellite launch to the Moon on Jan. 23, 1990. The Muses-A spacecraft includes a primary spacecraft that will swing by the Moon and fire a smaller spacecraft into lunar orbit. The spacecraft will give Japan experience in determining spacecraft orbits around a planetary body and demonstrate the high-efficiency data transmission technology necessary for future missions to the Moon and Venus. Japan hopes to play a role in the U.S. lunar base effort.

#### **SOVIETS REVEAL 1960'S MANNED MOON PLANS**

The Soviets showed hardware designed to land cosmonauts on the Moon in the 1960's to U.S. aerospace engineers from MIT and Cal Tech. Four test failures of the Soviet N1 heavy-lift

booster, which was analogous to the U.S. Saturn 5, halted the Soviet program. The Soviets planned to send two cosmonauts to the Moon and land one on the surface.

#### **SOVIETS EXPANDING THE MIR SPACE STATION**

The first of four expansion modules, Module D or Kvant-2, was docked to MIR on Dec. 6th. Module D contains the Soviet's new Manned Maneuvering Unit (MMU). The second large building block unit, Module T technological unit, is scheduled to be launched in late March or early April. It will contain furnace equipment for pilot industrial production of high quality semiconductor materials. The third module is Module O with an optical payload. The fourth module will be an ecological platform that will be made available to other countries.

## **DOUBLE, TRIPLE & MULTIPLE STARS**

**- PATRICK M. DONNELLY**

High overhead in early February is a constellation, that I only recently discovered is full of double stars. The constellation is Perseus, and it has the Winter Milky Way through the middle of the constellation. This time of the year it is not the easiest constellation to point the telescope at, because it is directly overhead. If you can overcome this minor irritation, there is a wonderful world of observing in for you.

Although it is difficult to tell you where to begin a good place would be Zeta Persei (R.A. 3hr. 47min, Dec. +31 deg.). Zeta is a multiple star with three (3) companions to the main star. The "A" component is mag. 3 and the secondaries are mag. 9.5 (at 13" sep & P.A. 209 deg.), 11 (33" sep & P.A. of 287 deg.), and 9.5 (at 94" sep & P.A. 195 deg.). There is another 9.5 mag star about 20" from the "D" component, which makes the entire field a nice sight. The "C" component at mag. 11 can be difficult to see. Therefore, use a high power eyepiece. The "B" and "C" components appear to have a common proper motion with the "A" component, so the Zeta is a triple system. The "D" component is an optical component. Next to Zeta is Omicron Persei. It is a double consisting of mag. 4 and mag. 8.5 stars separated by only 1". It is very difficult, and I have seen it only once.

A short distance from Zeta is Epsilon Persei (R.A. 3hr 51min and Dec. +39 deg.). Epsilon is a very easy double with mag. 3.0 and mag. 8.3 components separated by 9". continuing up to higher declinations is MU Persei (51 Persei R.A. 4hrs 12min, Dec +48 deg.). MU is a triple star although the "B" component is mag. 12 and difficult to see. The "A" component is

mag. 4.5 and the "C" component is mag. 10. The separations are A-B 14" and A-C 84". I have seen this triple, which is a true system, only with the 30-inch telescope at Fremont Peak. A 10-inch or 12-inch telescope under relatively dark skies should bring in all three components. While in the area check out some of seven open clusters in the vicinity of MU and extending up to Alpha.

Higher in declination still are Theta Persei (R.A. 2hrs 41min, Dec. +49 deg), Tau Persei (R.A. 2hrs 57min, Dec. +52 deg.). Theta is a pretty double and a true system. The components are mag. 4 and mag. 10 separated by about 18". The components appear green and yellow to me. Sigma 331 and Tau are very close. Sigma 331 is a true binary system consisting of mag. 5.5 and 6.5 pair separated by about 12". Tau is a triple system with the "A" component (mag. 5) separated from the other two, "B" & "C" by 52". The "B" component is mag. 10.5 and the "C" is mag. 11 separated by 3.5". These two components are just on the limit of visibility of my 8-inch telescope at 273X. I would suggest a bigger scope to fully view this triple.

Next, up near the Double Cluster is Eta Persei (R.A. 2hrs 43min, Dec. +55). This star is a real neck strainer, but it is well worth the pain. Eta has four components. The "A" component is mag. 4 and the "B" component is mag. 8.5 separated by 28" at P.A. 301 degrees. The "C" and "D" components are two mag. 10 stars separated from the "A" component by 66" at P.A. 269 degrees. These 2 dim stars are separated by 5". The 8-inch telescope is big enough for these, and a fine sight.

Finally, check out M34 (R.A. 2hrs 39min, Dec. +42.5), a fine open cluster in Perseus. This cluster contains two very fine double stars. The finder in Burnham's on page 1434 (Volume 3) is a must though. The first is h1123. It is listed as a pair of mag. 8.5 stars separated by 20". There is also a mag. 11.5 about 30" from the pair to make a nice triple. The other is OSigma 44 (OS44). OS44 is also a triple consisting of mag. 8, 8.5 and 9.5 components. The first two are separated by only 1.5" and the 9.5 component is 86" away. Use high power, and these stars will separate. There are other doubles in the cluster worth exploring too.

Let me close by asking for information. Lambda Orion is a multiple star above and to the right of Betelgeuse. Its dimmest component was mag. 11.5 companion separated by 78" at position angle of 271 degrees. Lambda's "A" and "B" components are separated by 4" at P.A. 44 degrees, so that you know the orientation. I have searched for the 11.5 mag. component in vain, until this Christmas Eve. On that evening the location, where the 11.5 compo-

nent supposed to be, had a mag. 8 - 8.5 star at the same location. There is also a brighter star a little further east. It appears as though this "D" component has brightened about 3 - 4 magnitudes. I have rechecked the star each clear evening since then, and I have confirmed my initial observations. Can anyone also confirm this? My name, address, and phone number are: Patrick Donnelly, 500 Corte Cabanial, Morgan Hill, CA 95037, 408-778-2741.

## COMET COMMENTS

- DON MACHHOLZ

**Comet Helin-Roman-Alu (1989v)**, dimmer than expected, has faded in our northern sky. Comet Aarseth-Brewington has gone south. But three new comets have been found recently, with two more returning comets recovered. Periodic Comet Tuttle-Giacobini-Kresak remains in our morning sky, you might want to monitor it for outbursts.

**Comet Austin (1989cl):** Rodney Austin of New Zealand discovered this, his third comet, on the morning of Dec. 7. The comet was technically in the evening sky, circumpolar at -62 degrees declination, and magnitude 11. He was using a Meade 8", f/4 reflector at 41x with a 1.7 degree field. Austin had searched for 49 hours over the last five years.

Since discovery the comet has moved northward, but from mid-northern latitudes it sets within an hour of evening astronomical twilight. The comet will be closest the Sun at 0.35 AU on April 9. After perihelion it will pop into our morning sky as bright as magnitude two. Over the following weeks, from late April through late May, the elongation increases while the brightness remains the same. This is due to a decreasing distance between the Earth and the comet, with the comet only 20 million miles away in mid-May. In early June the comet crosses opposition and into our southern evening sky, where it will dim over the summer months.

**Periodic Comet Skorichenko-George (1989e1):** Boris Skorichenko of the Soviet Union and Douglas George of Kanta (near Ottawa) Canada discovered this comet on Dec. 17. Skorichenko was using a 6-inch reflector. George was using a 16" reflector and has searched for 65 hours. The comet was magnitude 10.5 in the northern evening sky. It will be closest the Sun on April 14 at a distant 1.68 AU. Through April it will remain in our evening sky at magnitude 9-10. Elongation will decrease as it reaches perihelion on the far side of the Sun.

**Comet McKenzie-Russell (1989fl):** Patricia McKenzie and Ken Russel of Siding Spring

Observatory in Australia discovered this comet on plates taken Dec. 21. It was then Mag. 14 and moving 1.5 deg/day westward through Orion. The comet is now dimming as it pulls away from the Sun.

**Periodic Comet Van Biesbroeck (1989g1):** Jim Gibson of Palomar recovered this comet at magnitude 20 on Dec. 30. It may reach magnitude 15 when it arrives at perihelion in April 1991.

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## COMET EPHEMERIS

DATE (UT)	RA (1950) DEC	RA (2000) DEC	ELONG	SKY	MAG
Periodic Comet Tuttle-Giacobini-Kresak (1989b <sub>1</sub> )					
01-24	15h55.0m -13°39'	15h57.8m -13°47'	64°	M	11.2
01-29	16h19.3m -14°14'	16h22.1m -14°21'	63°	M	11.1
02-03	16h43.2m -14°39'	16h46.0m -14°44'	62°	M	11.0
02-08	17h06.3m -14°54'	17h09.2m -14°57'	62°	M	11.0
02-13	17h28.8m -14°59'	17h31.7m -15°01'	61°	M	11.1
02-18	17h50.5m -14°55'	17h53.3m -14°56'	61°	M	11.2
02-23	18h11.1m -14°45'	18h14.0m -14°44'	61°	M	11.3
02-28	18h30.8m -14°27'	18h33.7m -14°25'	61°	M	11.5
03-05	18h49.5m -14°05'	18h52.3m -14°01'	62°	M	11.8
03-10	19h07.2m -13°38'	19h10.0m -13°33'	63°	M	12.1

## Comet Skorichenko-George (1989e<sub>1</sub>)

DATE	RA	DEC	ELONG	SKY	MAG
01-24	21h16.2m	+31°37'	21h18.3m +31°49'	53°	E 9.4
01-29	21h30.6m	+32°43'	21h32.7m +32°56'	52°	E 9.3
02-03	21h45.8m	+33°52'	21h47.9m +34°06'	52°	E 9.2
02-08	22h01.9m	+35°02'	22h04.1m +35°16'	51°	E 9.1
02-13	22h18.9m	+36°12'	22h21.1m +36°27'	51°	E 9.0
02-18	22h36.8m	+37°21'	22h39.1m +37°36'	50°	E 8.9
02-23	22h55.7m	+38°27'	22h58.0m +38°43'	49°	E 8.9
02-28	23h15.5m	+39°29'	23h17.8m +39°46'	49°	E 8.8
03-05	23h36.1m	+40°26'	23h38.5m +40°42'	48°	E 8.7
03-10	23h57.4m	+41°15'	00h00.0m +41°32'	47°	E 8.7

## JUPITER'S RED SPOT

### Great Red Spot on Meridian PST

da	mo	d	h	m	da	mo	d	h	m	da	mo	d	h	m
F	2	2	2	10 am	M	2	12	8	15 pm	M	2	26	2	2 am
F	2	2	10	4 pm	W	2	14	2	7 am	M	2	26	9	53 pm
Sa	2	3	5	54 pm	W	2	14	9	56 pm	W	2	28	11	25 pm
Su	2	4	3	45 am	Th	2	15	5	41 pm	Th	3	1	7	17 pm
Su	2	4	11	33 pm	F	2	16	11	34 pm	Sa	3	3	1	4 am
M	2	5	7	27 pm	Sa	2	17	7	19 pm	Sa	3	3	8	56 pm
W	2	7	1	11 am	M	2	19	1	10 am	M	3	5	10	41 pm
W	2	7	9	8 pm	M	2	19	8	58 pm	Tu	3	6	6	25 pm
F	2	9	2	53 am	W	2	21	10	40 pm	Th	3	8	0	10 am
F	2	9	10	42 pm	Th	2	22	6	33 pm	Th	3	8	8	7 pm
Sa	2	10	6	41 pm	Sa	2	24	0	17 am	Sa	3	10	9	46 pm
M	2	12	0	25 am	Sa	2	24	8	7 pm	M	3	12	11	25 pm

## GREAT RED SPOT

- JIM VAN NULAND

With Jupiter past opposition, it is now high enough to begin observing without waiting for it to get high enough. You may find that the best seeing occurs during twilight, before the Earth starts radiating into the dark night sky.

Is your scope too small to show the Great Red Spot? Santa Cruz Astronomy Club member Tom Logan (Carmel, CA) observes with an 80mm refractor (Celestron Firstscope). His sketches and observing reports demonstrate that large scopes are not required to see the Spot, many details in the belts, and especially the Galilean satellites. He reports the Spot as fawn color, and that the North Equatorial Belt contains a number of darkenings of the sort I'd reported the last two months. This is a good opportunity to encourage observers to sketch what they see, not merely to provide a record, but also to train the eye to pick out the small details! Be sure to add the date, time, orientation, and what filters were used.

My most recent observations on Dec. 31st showed that the SEB is still absent; as before, the SEB region is very slightly darker than the South Tropical Zone adjacent to it.

Good seeing and a power of about 200-300 are needed. Begin half an hour before the given time. Focus carefully, then scan the southeast quadrant of Jupiter. Watch carefully for those moments when the air is especially stable, and the Spot will show itself in all its glory. Let me know of your results, especially if you are using an instrument smaller than 8-inches, or if you try various filters.

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## TELEMEX

### THE STORY OF A TELESCOPE IN MEXICO

- RICK McWILLIAMS

I took my telescope on vacation with me to Los Barilles, Baja California Sur, Mexico. It is a small town on a desert peninsula with a beautiful beach and ocean. There are some preliminary features of Mexico and Los Barilles in particular that are unusual. There are essentially no telephones or television. Most Hotels do not have or use room keys. Meals are included with your room. You can drink the water. You will get best prices in U.S. dollars as compared to pesos. You must slow down and enjoy Mexico, so do not get anxious over dinner being served late. I normally drink two cocktails each year, in Mexico, I have two margaritas every day.

With the help of a crating company I managed to get my 20-inch Dobsonian into four large boxes, 221 pounds in all. I was particularly concerned about the mirror. I built a box which consisted of two pieces of 1/2 inch birch veneer plywood separated by 1 x 4 fir edge pieces. The inside of the box was made octagonal by adding large corner gussets of 1 x 4 fir. The edges and bottom were joined by copious drywall screws and Titebond glue. The top was attached by 8 screws. Two large handles were added to the top so that it resembled a suitcase. Cushioned table leg ends were added to the top and bottom. These slide easily and indicate clearly that the box should be laid flat. Also when the box falls over they have a little give and cushion the impact. Two layers of clean tissue paper were placed on the mirror surface.

We arrived at San Francisco airport 2 hours early hoping that the oversize boxes would not look so troublesome. An airport skycap helped load our baggage onto a large cart. My wife Susie and I struggled into a place in line encumbered with two pieces of luggage and a heavy bag of wetsuits and snorkeling gear. I was glad that we arrived early as the line move very slowly. The agent at the ticket counter was hesitant to accept the boxes but her supervisor thought it was ok. The skycap took the two large boxes. The mirror slides off the cart! I told myself that I will assume the best and not open the mirror box now.

Our tickets indicated that we were going to Los Cabos via Puerto Vallarta, but this flight was going via Matzatlán. The international terminal has a little extra security allowing only ticket holders to go to the gate. The Sun rises with an unusual appearance of a Sundog. We hope to see our boxes loaded but the view of the airplane is blocked. A gate change is announced so we walk to the next gate. About time to board the airplane there is an unusual amount of activity around the jetway. It seems that our jetway is broken so we board the airplane by using the jetway ramp stairs and then the back stair of the Boeing 727 airliner. We are all aboard only 10 minutes late. The airplane is very full.

During takeoff I think about the excess 220 pounds of telescope. Takeoff is normal - 40 second ground roll. The pilot must be military as he uses steep banking turns and higher than normal roll rates. I understand, a Boeing 727 is really is a rather sporty airplane from the front seat. The stewardess announces that the front lavatory will not "floosh". Are we in Mexico already? The cabin attendants were continuously serving food and drink. The food was typical. I was hoping for the excellent meals of AeroMexico.

The flight was beautiful. Desert scenery of California and Mexico was terrific. The Sea of Cortez with its many islands and beautiful colors was entertaining.

We land exactly on time in Matzatlán. Immigration processing is simply a rubber stamp on our tourist cards. It is refreshingly hot and humid. The terminal is small and the passengers are confused, everyone smokes. We re-board for the 40 minute flight across the Sea of Cortez to Los Cabos. The pilot departs with a sporty steep turn and we are on our way. The flight attendants squeeze in another meal with cocktails.

We land at Los Cabos, the pilot hurries the landing and uses a lot of reverse thrust. We leave the plane and wait for our baggage. We find two Mexican skycaps and have them look for the big boxes. Baggage is unloaded and our boxes arrive. We did it! We proceed to cart the boxes toward the taxi desk. A strong tanned man in a uniform has another idea. "I want you to open the boxes." I notice the well worn .45 pistol in its holster. "Certainly, no problem." I answer, trying to explain that this is a telescope. We open the mirror case and I show him the mirror. The agent from Mexicana has arrived and is trying to help. He translates for the sergeant. We show the receipt for the telescope. He explains that we cannot take the telescope with us. He says it will take a week to process the temporary importation of a telescope. I explain that Tuesday is the New Moon and that I must have it to use then. The sergeant writes a detailed receipt with 5 carbon copies and stamps each one. He needs a model number, I tell him it is a Sky Designs VPT-20. Very Portable Telescope does not seem to describe it. In Mexico B's and V's sound the same so I think Barely Portable Telescope. I will return on Tuesday to pick it up. He keeps three of the telescope boxes and lets me take the mirror.

I am confident that we will get the telescope on Tuesday. We pay for a taxi at the taxi desk. The airport taxes are hopped up VW vans. Our young driver is enthusiastic and we are off. The desert between Los Cabos and Los Bariles is very interesting. Strange trees and cacti. Vultures circle near the highway. The driver plays chicken with cattle crossing the road. He must be an aspiring race driver, the engine is always at full power. We pull into a PEMEX gas station and he does a 20 second fill-up. Off again, the VW's engine screams to get us up the hills at 80Km/h. We think that we see the back half of a bobcat crossing the road. Ahead we see Los Bariles. I sure hope he knows where the hotel Palmas de Cortez is located. He does, it is right on the airstrip. We go into the office and register for our room. It is number 31 - good,

sounds like the ground floor. A little kid tries to wrestle the mirror case from me so that he can carry it for us. I win the wrestle. Our room is upstairs. The beds are not yet made. I decide to ask for a downstairs room. No problem, use number 26. The hotel doesn't use room keys so changing rooms is easy. The weather is terrific. Clear sky, warm, gentle breeze. I am pooped.

We proceed to look for Hector to claim our welcome margarita. Who is Hector? We find the bar and the bar tender is a serious character - he is Hector. The Mexican margarita is uniformly excellent. Hector is amazing. Susie and I would come in several times during the day and ask for "agua con hielo," water with ice. He would make us feel welcome sitting at his bar with our cocktails. We immediately meet people who become friends. Outside we drink our margaritas and tell the telescope story and wait for dinner. We soon discover that the toilet in our room is only partly functional. This is the Mexico I remember. A little fussing in the tank gets it working. The shower is a little weak but it felt terrific. We can slow down and change to Mexico time.

Tuesday, we meet the hotel owner, Cha Cha. She explains that Customs is very wary of guns, ammunition, and jewels. She doesn't think that they were looking for a tip. I ask her where we can set up the telescope and invite her to come that night and look through the telescope. We find a taxi driver with a large Dodge van. Off we go to the airport, this time for sure. I have rewarmed my Spanish. We proceed to the Mexicana desk, they invite us to step through the baggage slot and we go to the business office. They read the receipt from Customs. They send us to the Customs office for arriving flights. We meet two sergeants who walk with us back toward Mexicana. Uniforms and guns make me nervous. My marginal Spanish seems to work. The taxi driver, Raul, helps the communication. To my surprise these two sergeants meet with a well dressed woman. They shake her hand as if it were an honor. She is the head of Customs. We proceed to a small office.

The Customs officers discuss our problem. The woman decides to help us and directs another sergeant to write a special condition on my tourist card. It says that I must be accompanied by 3 boxes containing telescopes when I depart. They really are concerned about the possibility of uncontrolled importation. I get my boxes. We struggle with the boxes into the taxi where they barely fit. It is difficult to latch the vans rear doors.

I look forward to unpacking the telescope at the hotel. We get right to work and have the telescope mostly unpacked and assembled in an hour. We find that bead type polystyrene pack-

ing material is a messy mistake. White stuff is all over everything. We use some tape to pick it off before we install the mirror. When you need to install a large 20-inch mirror there are no volunteers to help. I check the collimation, using the Tectron Cheshire eyepiece. It is way off, I adjust it like an expert, though I faintly remember how I screwed it up the first time.

At dinner the rumor of the telescope is everywhere. They noticed the big boxes. We set up at the south end of the hotel. It is a dark sky. Shorts and tee shirt conditions. We align the Celestron "Advanced Astro Master" computer and begin a star party. First we view Jupiter, the sky is excellent, too bad that beginners cannot move the telescope at high power. A group of 10 to 15 people hang around - they all get a time at the eyepiece. Cha Cha arrives and is impressed by the size of a 20-inch telescope. "Now I see why you had a problem with Customs." Later she returns with her son, two cooks, and others.

We demonstrate the "Advanced Astro Master" computer and look at M37, M42, M31, M81, M82, and M1. The computer does good work as I can guide the telescope using the computer display while a beginner is at the eyepiece. The American hotel guests are amazed by the computer, its scrolling descriptions and the ability to name stars. We cycle through these objects going back for each new observer. We bring on the high power as the star party guests get the hang of driving. Jupiter shows its red spot, many festoons, bands, and other spots. At full aperture and 425 power. I am pooped!

I try to remember windsurfing, my arms have atrophied over the last two years. The Baja Surf Club provides us with mountain bikes. Terry Wild leads mountain bicycle rides into the interesting back country. We visit the water supply and see small waterfalls. The owner of the Baja Surf Club, Dirk, thinks that Customs made it easy for us. Apparently the temporary import paperwork is serious and involves a deposit. The next night it rains. Hector's margaritas are terrific.

We hire Raul and his taxi to go to another hotel. Hotel Leonero is at the end of a 10 mile "so rough" dirt road and is all by itself. There are 11 rooms. We have an excellent giant room, 4 beds and a crib. The south side of the hotel has no lights and a large flat area. It will be excellent for observing. It is dark, the sky is clear. Jupiter shows its spot again and other details. We look at many objects - the stars of the southern cross are visible singly. The Magellanic clouds hide resolutely behind a mountain! It is a fun star party. The taxi driver Raul shows up and we show him stars, galaxies, and nebula. The

Mexicans are very appreciative of the opportunity to see astronomical objects. Many of the partiers have exceeded a rational limit at the bar. We observe until midnight. Some dewing affected the secondary mirror. It is hard to play in the Sun all day and observe late into the night.

Susie and I ride mountain bikes and walk for miles on the beach. I try to learn to fish off the beach in the reef. We catch an octopus which is very difficult to get off the hook, three kinds of puffer fish - we puffed one up in a tidepool, a tiny spotted eel that I would not touch, and other pretty fish. We put them all back in the sea. The wind blew 20 knots, the windsurfers loved it, the fishermen didn't. The desert environment on the Sea of Cortez is loaded with birdlife. Pelicans, Vultures, Gulls, Osprey, Frigate birds, Cormorant, Egrets, Herons, Hawks, Golden eagle, Kingfishers, and many other small birds. The night sky was like pages from H.A. Reys constellation book. Clouds exposed single constellations and stars. Orion now, then Canes Major, then Auriga, and finally Regulus. I did not setup the telescope.

The next day is sparkling clear with light winds. We have a good time. The sky completely clouds over during dinner. Susie accidentally orders a double margarita on the rocks and is funny for the rest of the night.

I snorkel over the reef where we fished. The water is not very clear due to the heavy surf. There is a tremendous variety of colorful fishes. The reef showed at least 4 fish at all times, some in schools of 30 or more. They say that diving and fishing is best from February to August. We were fishing in the right place. The bottom is very rough limestone conglomerate, I am surprised that I was ever able to reel in my hook without the aid of a fish.

Our last night arrives too soon. The sky is clear. We have a good time with the hotel staff and guests at the telescope. Jupiter again shows its red spot. Transparency is excellent, stability about 1 arcsecond, extinction near the horizon is stronger than usual. The Sky Designs 20-inch telescope performed very well, only primary mirror collimation was required after shipment. The Astro Master performed well, it named the southern circumpolar stars which were on the horizon. Susie did some homework and provided me with a list of deep sky objects in the southern sky. Finally, I was alone at the eyepiece. I viewed several obscure NGC galaxies. Then back to skytouring my favorite Messier objects.

The next morning we pack the telescope. I hope that things will go smoothly at the airport. Raul's taxi has a problem so he sends a friend with a large van. I am tired, I need a vacation. It

is an hour drive to Los Cabos airport. We watch for wildlife along the road. The taxi driver wants to talk, I explain the importance of the ball marking the Tropic of Cancer along the highway. My Spanish is improving.

At the airport we find the "Aduana" office and he signs and stamps my tourist card. Mexicana airlines is very cooperative and doesn't charge any excess baggage. The check in really didn't deserve the anxiety. We actually see them load the telescope onto the right airplane. The front lavatory is again broken. The flight departs 10 minutes late, we arrive on time at Matzatlan. Immigration stamps my tourist card without noticing the extra stuff. We are soon on our way. Susie has the window seat, it seems that I hogged the view on our way down. The flight attendants try to feed us continuously. I am looking forward to U.S. customs.

We land at San Francisco on time. Our baggage arrives quickly at the carousel and soon a Mexicana agent brings the large boxes in a side door. There are no skylaps as this is some kind of secure area. We manage to balance it all on two carts. The mirror manages to slide off and crash on the floor. I hope for the best. An immigration officer snarls something at Susie. We select another line. We are quickly processed. We explain that the large boxes are a telescope. The immigration man comments, "I didn't know that they had dismantled Palomar?" He marks that we have a telescope. Customs lets us through without any kind of inspection. Out on the highway we wait for Hildy, she walks up from behind. The telescope fits more easily into the station wagon than before. We are almost home. The next day I unpack the telescope, everything is OK. White polystyrene crud is everywhere.

The telescope added to the adventure. I will do it again. I will bring a smaller telescope, pack it in a large cooler and say nothing about it to Customs. Mexicana airlines did very well for us, but Alaska airlines has as many flights and is better organized. I have my hotel reservation for the July 11, 1991 eclipse event.

*From the Editor* - I'd like to take this opportunity to thank both Rick and Susie for letting me run their Mexico story. It is always a real pleasure to read personal accounts like theirs, especially when it combines a little adventure and amateur astronomy. I can't think of a better way to make new friends, than to set up your telescope and invite newcomers over for a view of the heavens. I recall my first star party at Glacier Point. The foreign visitors were the most appreciative, having the opportunity to look through my C14. When in New Zealand, we invited the hotel staff out to view Halley's with our telescopes. They were really excited

about this and delivered us hot coffee most of the night in appreciation. It's nice to erase the "Ugly American" image for a change.

Do you have a personal account that you would like to share with other SJAA members? Your Editor would welcome any submissions.

## FROM THE COSMIC MIND-BOGGLING BOOK

- NEIL McALEER

### ALMOST A STAR

The composition of Jupiter is very similar to that of our own Sun; 89 percent hydrogen and 11 percent helium. Its average density is only 1.3 times that of water; it is a gaseous sphere with no solid surface. Jupiter radiates about twice as much heat energy as it receives from the Sun, which comes from an internal reservoir of heat left over from its creation some 4.6 billion years ago. This thermal heat slowly works its way up to the surface and, along with the rapid rotation, helps to maintain a remarkably constant temperature between the equator and the poles and between the day and night hemispheres - about -138 degrees Celsius (-216 degrees Fahrenheit).

Great Jupiter is about as large as a planet can be without being a star. If it has more mass, it would not grow in size as might be expected; rather, the extra mass would cause it to shrink from self-compression under gravity. Indeed, if Jupiter were about 60 times more massive than it is, thermonuclear reaction would ignite, and the energy produced would overcome the gravitational shrinkage. Jupiter would then become a self-luminous star instead of a planet, with a diameter of more than 100,000 miles (161,000 kilometers).

### JUPITER'S CORE

The deep interior core of Jupiter, probably composed of iron and silicates and about the size of the Earth or Venus, has a temperature of about 30,000 degrees Celsius (54,000 degrees Fahrenheit). While this is 100 times hotter than any terrestrial surface, it nevertheless is 500 times cooler than the temperature at the center of the Sun. The tremendous pressure in Jupiter's core is more than 30 million times higher than the Earth's atmosphere. If planet Earth were ever subjected to such immense pressures, it would be compressed to little more than half its present diameter and to a density of 3 to 4 times that of iron.

### THE JOVIAN SEA

Surrounding Jupiter's core is a shell of metallic hydrogen over 25,000 miles (40,000) thick and

exotic form of hydrogen never found on Earth. Although we usually think of hydrogen as gas, under the high pressures in Jupiter's interior, it is compressed into a metal. At the outer limit of this metallic hydrogen shell, the temperature has cooled off to 10,500 degrees Celsius (19,000 degrees Fahrenheit) and the pressure has dropped to about 3 million atmospheres. An outer shell, about 15,000 miles (24,000 kilometers) thick, is composed of liquid hydrogen, and this continues until the hydrogen becomes gas, which marks the depth at which Jupiter's interior becomes atmosphere and cloud layers. In this sense, Jupiter's entire "surface" is a sea of liquid hydrogen at a temperature of at least -252 degrees Celsius (-422 degrees Fahrenheit).

### THE JOVIAN CLOUDS

The high white and yellow cloud tops of Jupiter are composed of frozen ammonia crystals and have temperatures in the range of -130 degrees Celsius (-202 degrees Fahrenheit). A lower cloud layer is composed of ammonium hydrosulfide crystals at about -73 degrees Celsius (-100 degrees Fahrenheit). The lowest cloud layer lies about 43 miles (69 kilometers) below the top of the high, visible ammonia clouds and 560 miles (900 kilometers) above the liquid hydrogen ocean. Temperatures would be in the 30-degrees-Celsius (86-degree Fahrenheit) range. Here, clouds of water droplets and ice crystals are found. At somewhat lower altitudes, the warmer temperatures would create steam. These water regions of the Jovian atmosphere are more Earthlike than any other feature of the planet.

Exactly how Earthlike? Could, for example, a future astronaut on a Jovian atmospheric expedition open up a portal of his ship and let the outside in? The answer is no. The atmosphere would still be mostly hydrogen and helium, without a trace of breathable oxygen. In addition, it would contain quantities of such noxious, smelly gases as ammonia and hydrogen sulfide, topped off with doses of phosgene and cyanide.

### THE GREAT RED SPOT

A storm has been raging on Jupiter for over 300 years, a storm that could swallow up the Earth -- three of them, in fact. The great red spot, a vast cyclonic system, has had a diameter as large as 25,000 miles (40,000 kilometers), 3 times the diameter of the Earth. Fifty of the Earth's largest hurricanes could be placed side by side before they matched the width of this largest known storm in the solar system.

### SPIN, JUPITER, SPIN

Jupiter is the fastest rotating planet in our solar system, spinning on its axis once almost every 10 hours at its equator. A stationary object at its equator would be traveling at 27,720 miles

(44,601 kilometers per hour, which is substantially more than the escape velocity from planet Earth - the speed at which a spaceship launched from Earth can escape from our planet's gravitational shackles and into the depths of space. Voyager 1 almost reached this speed when it was launched September 5, 1977, toward Jupiter, and it took almost 1,300 spins of Jupiter (each Jupiter day about 10 hours long) to reach the giant planet, compared to about 540 days that passed on Earth.

### SIZING UP THE GIANT

Jupiter the giant, well known as the largest planet in our solar system, contains 71 percent of the total mass of all the planets. Its diameter of 88,748 miles (142,796 kilometers) is 11 times that of the Earth, but a comparison of surface areas is much more impressive. If the surface of Earth could be peeled off like an orange skin and spread out against the surface of Jupiter, its area would be to Jupiter as India is to Earth. Left unpeeled, the Earth would be the size of a dime when Jupiter was the size of a dinner plate.

### A SATURN V LAUNCHED FROM JUPITER

Jupiter has the highest escape velocity of any planet in the solar system - 136,371 miles (219,600 kilometers) per hour - because its huge mass gives it the strongest gravity.

Would a Saturn V moon rocket escape from Jupiter's powerful gravity if launched from the planet's strange liquid hydrogen "surface"? At first the rocket would sit on the launch pad until it had burned off about half the propellant in the first stage. Then it would struggle upward and eventually reach a speed of about 2,500 miles (4,000 kilometers) per hour and cover a range of only 30 miles (48 kilometers). The second stage would then start burning, but before this stage burned up enough fuel where its thrust could be effective against Jupiter's gravity, it would have crashed. So the same rocket that could deliver 50 tons to the Moon from Earth would do no better than a long-range artillery shell if launched from Jupiter's surface.

### THE FASTEST MOON

The fastest-moving moon in the solar system, discovered in the Voyager spacecraft photos and officially designated 1979 J3, swings around Jupiter once every 7 hours 4.5 minutes. Only 25 miles (40 kilometers) in diameter, it revolves around the giant at an average distance of over 35,000 miles (56,549 kilometers) above the Jovian cloud tops. Its velocity has been calculated at 70,400 miles (113,600 kilometers) per hour - a speed that would take you from New York to San Francisco in 2 minutes 11 seconds.

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