

# THE FOCAL POINT

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## CLUB CALENDAR

**Next Meeting:** October 20, 8:00 p.m. at Bradley Observatory.  
**Program:** Agnes Scott astronomer Dr. Alberto Sadun will present a talk entitled "Extragalactic Radio Jets".

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Richard Jakiel, Mark Lancaster

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**Submissions:** Article submissions are welcome, and may be delivered to the editor for consideration. Articles on computer floppy disk are encouraged.

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## IS PLUTO AN ESCAPED SATELLITE OF NEPTUNE?

by Tom Van Flandern

The recent Voyager encounter with Neptune has revived speculation that Neptune's unusual large moon, Triton, was captured early in the history of the solar system. The basis of this conjecture is primarily that Triton is the only large moon of any major planet (ignoring asteroid-sized bodies) which revolves in a retrograde direction around its primary. ("Retrograde" means in the opposite direction from the spin of the primary.)

There is no known way that such a satellite could have formed naturally in such an orbit. It could not have fissioned (broken off) from Neptune, because Neptune's spin would have caused it to orbit in the expected direction. Nor could it have condensed from a cloud of material in orbit around Neptune, because the cloud of material, which must also have helped to form Neptune in the first place, had to be responsible for starting Neptune spinning the other direction. The only remaining option appears to be that Triton formed elsewhere, and was captured by Neptune into its backwards orbit.

There are problems, however, with this capture conjecture. Where are we to suppose that Triton formed, if not as a moon of Neptune? Didn't Neptune ever have any natural satellites of its own? And most difficult of all, how is it possible for Neptune to capture Triton? Let me elaborate on this last question for a moment.

When only two rigid bodies interact, and gravity is the only force involved, capture and escape are impossible. If a body is a satellite, it remains a satellite forever; if not, it cannot become one. The "sphere of influence" is the volume within which a mass can hold satellites permanently bound to itself. One body cannot move permanently into the sphere of influence of another body without the assistance of a third body or the intervention of a force other than gravity.

If two bodies have the same or similar orbits, gravitation always works to keep them apart. The motion of the smaller body is called libration: it repeatedly gains and falls back in its orbit relative to the larger body, but never approaches it. This situation (called "libration") exists in several instances in the solar system. The most notable examples are the "Trojan asteroids", which orbit the Sun in the same orbit as Jupiter, but can never approach the giant planet very closely.

Intervention by a third mass at just the right moment to permit a permanent satellite capture by Neptune is an extremely improbable event. Moreover, no suitable third bodies massive enough to accomplish the job are known to exist in the outer solar system today. The force of tidal friction is far too weak to accomplish the capture of Triton, to say nothing of the low probability of the right circumstances occurring. Drag in a medium of gas and dust surrounding Neptune could not slow Triton enough to permit capture, unless the medium were dense enough to remove more velocity than Neptune itself adds to Triton as it approaches. A medium so dense as to remove that much velocity would cause the decay of Triton into Neptune's

atmosphere within a few revolutions through continued drag.

It is true that there is an avenue of approach of a potential satellite, through the so-called "inner Lagrangian point", on just the right trajectory with just the right speed in just the right direction in all three dimensions, which would bring a potential moon close enough to Neptune with a small enough relative velocity that a non-gravitational force could then capture it. But the odds against such a fortuitous approach are so enormous as to make this loophole a practical impossibility. Even if there were millions of Triton-like objects at the time and only one was going to be captured, the odds against capture are still overwhelming. The easiest way to make capture work is to have millions of Triton-like bodies, and have one of them approach close to the optimal trajectory while an even larger mass impacts on Neptune, accreting enough new mass onto Neptune that the planet's sphere of influence enlarges, capturing the nearby Triton permanently.

Since none of these capture mechanisms seem very plausible, let us examine the alternatives to capture. First we need to look at the overall picture in the outer solar system. Neptune has rings and small inner asteroidal moons, very much like the other gas giant planets. But it has no large normal moons, unlike the others. In addition to the abnormality of Triton's retrograde motion, Neptune's other long-known moon, Nereid, is on an extremely elongated orbit, far more eccentric than that of any other moon in the solar system, and quite close to the threshold of escape.

Add to this picture two moon-size bodies: Pluto, and Pluto's own large moon Charon. This pair orbits the Sun in a planetary orbit which crosses the orbit of Neptune. This in itself is an extraordinary situation, since crossing orbits are usually unstable (i.e. eventually these bodies either collide with Neptune or are ejected from the solar system by it).

Now it could be the case that Pluto and Charon are the fortunate survivors of millions of Triton-like bodies. If so, it is odd that their orbits cross that of Neptune, since non-crossing orbits are far more stable. Why aren't there lots of similar bodies in many of those stable orbits?

The other gaseous giant planets, Jupiter, Saturn, and Uranus, have large natural satellite systems with more or less circular, co-planar, equatorial, regularly-spaced orbits. Although Neptune's two outer satellites appear typical in respect to mass and physical characteristics, their orbits are most abnormal. It seems altogether fair to suggest that Neptune may have started with a normal system of satellites, similar to the other gas giant planets; but then something disrupted that satellite system, making the orbits abnormal.

Could that disrupter have been Pluto? Pluto's mass is too small to change Triton from prograde to retrograde under any circumstances. Moreover Pluto could not have escaped into an orbit with so much greater a mean distance from the Sun than Neptune's without the intervention of a far more massive body.

If Triton had been the body Pluto interacted with, Nereid's orbit would still be unexplained, and vice versa. The existing situation can be efficiently brought about, it would seem, only by the intervention of some mass larger than either Pluto or Triton; in fact, larger than any existing solar system moon.

To test whether a larger mass could in fact bring about the existing situation, R. A. Harrington and I (in work done at the U.S. Naval Observatory) calculated test encounters with hypothetical bodies of varying mass, encounter distance, inclination, and velocity. We started with an assumed regular four-satellite system for Neptune, modelled on Jupiter's four Galilean satellites. The findings were illuminating: to produce disruptions of the observed sort, the encountering body needed to have a mass in the range of two to five Earth masses, and a velocity similar to outer planet velocities (but not as high as that of bodies coming from outside the solar system). In other words, the only hypothetical encountering bodies which worked well in disrupting the Neptune satellite system as observed were what we might call "Planet X"-type bodies, previously in planetary orbits around the Sun beyond Neptune.

The computer calculations eventually, by trial and error, found an encounter by a 3-Earth-mass body which could simultaneously reproduce a Triton-like, a Nereid-like, and a Pluto-like post encounter orbit for three of Neptune's original normal satellites. A fourth original satellite could then be added in such a way that it would go off with Pluto, and become Pluto's satellite Charon, among other possibilities. Despite its small mass, Pluto's gravitational sphere of influence is 10,000,000 km, as long as it stays away from Neptune's sphere of influence. So if Charon were pulled away from Neptune in the same general direction and with a similar velocity to Pluto, it would become permanently gravitationally bound to Pluto, because it would necessarily start out INSIDE of Pluto's sphere of influence. With little velocity relative to Pluto, Charon would initially fall toward Pluto, entering a highly elliptical orbit. Tidal forces would then circularize Charon's satellite orbit and synchronize the spins of both bodies, which is precisely the situation we observe today.

Although the body doing the disrupting might have escaped the solar system following the encounter, the statistical odds are that it would have remained in a highly eccentric and inclined solar orbit with a long period. This is just the sort of body which has been suggested as a hypothetical undiscovered planet beyond Pluto, based on unexplained disturbances in the orbits of the outer planets. Certainly, if such a "Planet X" were to be discovered in a highly-inclined and eccentric orbit which approached Neptune's orbit at perihelion, and has a mass near the interesting range of 2-to-5 Earth masses, its existence would argue strongly for the essential correctness of the whole scenario we have just described.

We conclude that a plausible explanation for the unique irregularities in the satellite system of Neptune (retrograde

motion of Triton and a "comet-like" orbit for Nereid), and also for the existence of moon-sized planet Pluto and its satellite Charon in Neptune-crossing planetary orbits, is that an as-yet-undiscovered trans-Neptunian planet had a close encounter with the Neptune system sometime in the past. If so, Pluto and Charon are probably indeed escaped former satellites of Neptune.

It is also interesting to note that Triton's orbit has been circularized by tidal friction. That fact plus recent Voyager indications that the moon is currently undergoing geologic activity suggests that the rate of tidal evolution may well be greater than usually assumed. The ultimate fate of Triton under the influence of this tidal activity, perhaps in as little as a few tens of millions of years, is to decay into the atmosphere of Neptune, and eventually be assimilated by the planet. Now THAT will be one spectacular satellite re-entry!

*The author is a professional astronomer currently writing a book which discusses a number of radical new ideas about the history of the solar system.*

### AAC JOINS THE BOOK OF THE MONTH CLUB

Are you tired of looking at your lame astronomy book collection? Don't you wish that you knew which books were relevant to you, without clumsily picking and choosing at the local bookstore where they think they know what you want? Wouldn't you like to buy books and atlases at discount prices?

The Atlanta Astronomy Club is now instituting, on a trial basis, a new service to be available to all members. We are currently working with a number of distributors to obtain volume purchases of astronomy books. Each month, a book will be announced in each issue of the Focal Point and at each meeting, with an invitation to purchase them for your own collection. Many of these books will be available at discount prices. The Atlanta Astronomy Club strongly encourages you to please consider taking advantage of these offers, as they will help provide additional funding for our observatory and educational budgets.

In order to receive a maximum savings on orders, a minimum number of books must be reserved before the book orders can take place. Books that do not receive an acceptable response will be withdrawn.

The first AAC book of the month is...(drum roll, please)...the 1990 Astronomical Calendar, by Guy Ottewell. Published by the Astronomical Workshop at Furman University, this is actually several pages of insightful information on lunar and planetary positions, comets, eclipses, meteor showers, asteroids, and even

includes a brief description of significant events in space exploration. This is probably one of the most comprehensive annual guides for amateur astronomers. Softbound, 11" by 15", approximately 76 pages in length.

The 1990 edition will be shipped around the first week of December. This order will be placed regardless of the number of reservations. This book will cost \$14.00 per member. However, if at least 20 reservations are made, the price will drop to \$12.00. Order one for a friend! To reserve your copy, let Hal Crawford know at the October meeting or call him at 320-9156. The deadline for this will be mid-November, so let him know ASAP.

### THE CASUAL ASTRONOMER: OCTOBER 1989

by Hal Crawford

#### Galileo Under Attack!

There is some late-breaking news that I simply cannot ignore. As I am sitting here, I have just learned that at the next scheduled launch of the shuttle Atlantis on Thursday, October 12, a group of nuclear protesters and peace advocates (?) intend to descend upon Cape Canaveral. They intend to protest -- not the shuttle -- but the shuttle's payload, the Galileo explorer. As I have already reported on these venerable pages, the explorer is to be launched from the shuttle and travel to Jupiter, where it will release a probe into the Jovian atmosphere. This probe will reveal significant information about the atmospheric composition, pressure and temperature as it descends into the planet. All this information will be collated and transmitted back to Earth. The scientific objectives include revealing clues about the history of our solar system, and possibly leading to a greater understanding of our Sun and home planet.

It seems that Galileo will be powered by a nuclear power supply. Explorer missions are typically powered either by solar cells or nuclear generators. Interplanetary explorers that extend past, say, Mars, simply can't economically fit enough solar cells to make a mission to Jupiter practical. Thermonuclear generators are a tested form of power that have even been used on the Voyager spacecraft.

This, of course, is what the protesters are upset about. Although some of those protesters are philosophically opposed to nuclear power in any form, regardless of benefit, the primary argument is that they are afraid that a nuclear accident will occur during launch. To illustrate this concern, many people became gravely concerned after the Challenger disaster. After all, what would have happened if Challenger had been carrying a nuclear payload? What sort of havoc would have resulted with Challenger blowing up with Galileo?

NASA officials assure us that even if (God forbid!) the Atlantis should follow the unlikely fate of Challenger (or worse), the 50 pound Plutonium bound within the Galileo payload would still be secure. Of course, this is not good enough for the protesters. I understand that they are suing to halt the launch.

This is absolutely, positively ludicrous. First of all, what do peace advocates have to do with a NASA explorer using a nuclear power supply??? Second, despite what the anti-nuclear forces will probably tell you, there is no chance of the nuclear payload turning Atlantis into the next Hiroshima. While no one wants nuclear debris scattered over their heads, the data indicates that the situation would not be as serious as the protesters would have you believe.

The summary is painfully simple. These protesters are turning a valuable research project of substantial proportions into a political football. These people want to pursue their own agenda at the expense of NASA, astronomy, and any real or imagined fears that stand in their way or can be maneuvered to their advantage. While there is certainly room for conscientious debate from both sides for earthbound nuclear power, the debate should not have anything to do with Galileo, which has already taken far too long to get off the ground.

### OCTOBER PROGRAM PREVIEW

The October program, "Extragalactic Radio Jets", will be presented by our host, Alberto Sadun, Ph.D., of Agnes Scott College. While powerful radio sources outside our galaxy have been known for decades, it has been only in recent years, since the completion of the Very Large Array (VLA) radio telescope, that sufficient resolution has been possible to recognize the jets for what they are. Dr. Sadun has made the study of these mysterious objects his speciality. The radio jets are now considered prototypes for a whole new class of objects which are achieving recognition for their importance in understanding galactic evolution. You won't want to miss this exciting and fully-illustrated presentation!

## THE FOCAL POINT

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