# A Mysterious "Perturber" at the Edges of Our Solar System



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- Daniel Whitmire, Ph.D., Professor of Physics, University of Louisiana, Lafayette -

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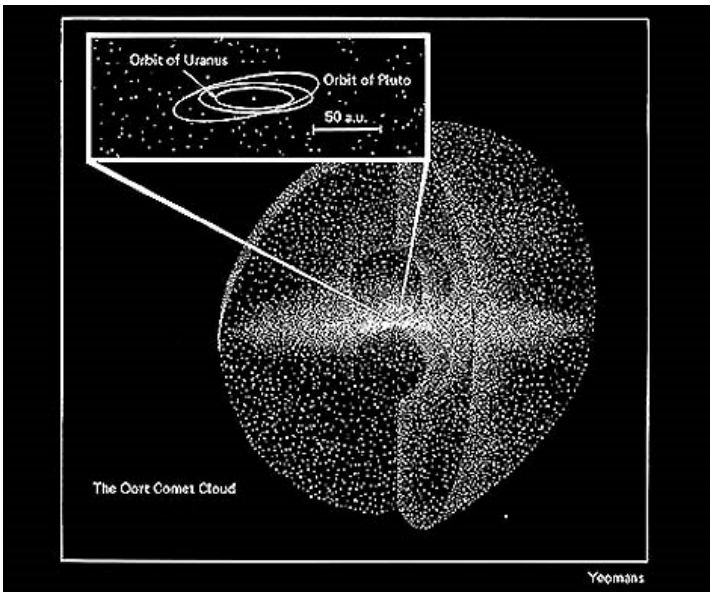
**October 25, 1999 Lafayette, Louisiana** Physicists in the United States and England have been studying the orbits of comets and are theorizing that something is pulling on the icy clumps that revolve at the dark and outermost edges of our solar system. The "perturber" might be a brown dwarf three times more massive than the sun and orbiting about three trillion miles from earth in the primeval Oort Cloud of ice, rocks and dust that literally surrounds the family of sun, planets, moons, asteroids and comets in our solar system.




Inset depicts nine planets of our known solar system embedded inside the large cloud of debris left over from the formation of our system known as the Oort Cloud. The hypothetical planet or brown dwarf "perturber" would be about halfway out from the center of the cloud. Diagram courtesy University of Michigan/NASA, 1999.

A brown dwarf is a failed star. Normal stars shine like the sun and do so because

of thermonuclear reactions in the center of the star. But in order for the thermonuclear reactions to take place, a star's central temperature has to be millions of degrees. That will occur if the mass of the star is above 8% the mass of our sun. If less than that, the almost-sun never ignites and becomes a brown dwarf.

Observational data to support the theory of a brown dwarf far beyond Pluto will be laid out in a paper to be published in the prestigious astrophysics journal Icarus in November. One of the authors is Daniel Whitmire, Ph.D., Professor of Physics at the University of Louisiana, Lafayette, where he has taught for twenty-five years. He and another physics colleague, John Matese, have collaborated on celestial mechanics and dynamics problems, including the mystery of uneven distribution of comets in our solar system. Recently I talked with Dr. Whitmire and asked him what provoked his interest in the orbital anomalies of comets in the first place?

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## Interview:

**Daniel Whitmire, Ph.D., Prof. of Physics, University of Louisiana, Lafayette, Louisiana:** "What provoked me was the discovery by two paleontologists at the University of Chicago that the fossil record showed mass extinctions on earth were not at random, but had a regular pattern to them that occurred every 26 to 30 million years. And so if that's the case, then you need a model to explain that. And prior to that, it was discovered that the impact of a large comet or asteroid was responsible for the mass extinctions of the dinosaurs and two-thirds of life on earth 65 million years ago. So, it was sort of natural to consider a model in which all the mass extinctions were due to impacts of comets or asteroids.

But it's not that easy to come up with a model in which the earth gets struck by a comet every 26 to 30 million years. There were two or three models proposed at the time. The Nemesis Model was one that I proposed and published in 1984, a model in which a small companion star to the sun perturbed the comets in the Oort Cloud. So I got interested in the dynamics of a possible solar companion star, a small star, in 1984.

The Nemesis theory involves a brown dwarf out in the Oort Cloud. But the objective of the Nemesis Theory was to give the brown dwarf a proposed orbit such that it came into the inner part of the Oort Cloud where it perturbed the orbits of comets there causing a fraction of them to be shot into the inner solar system where they would collide with the earth. So, again this was motivated by an attempt to explain why mass extinctions as well as crater periods on the earth seem to follow a pattern. But the required orbit for Nemesis had to have a lot of eccentricity, a lot of elongation, for that model to work.

This brown dwarf we're now proposing doesn't really fit my original Nemesis idea at all, but we're just driven to this new theory by the data as we see it. The data tells us what the orbit of the comet orbit perturber ought to be and it's not like the orbit of Nemesis. But it would be out in the Oort Cloud, too, without the terribly elongated orbit that a Nemesis would have to have.

**YOU DON'T THINK THIS PROPOSED BROWN DWARF NOW THAT YOU'RE GOING TO BE DESCRIBING IN *ICARUS* COULD BE RESPONSIBLE FOR THE CYCLIC 26 MILLION YEAR EXTINCTION CYCLES ON THE EARTH?**
No, not on the basis of what we understand at the moment. I don't think so. And Nemesis and this brown dwarf are not mutually exclusive. You could still have a Nemesis out there far out at aphelion and not be affecting the comets today and then at some future date 13 million years from now, it could plow into the inner Oort Cloud and do its thing. So, the two things are not exclusive. Just because I don't think this Brown Dwarf is not Nemesis doesn't mean that there can't also be a Nemesis out there.

**BETWEEN 1984 AND 1999, WHAT HAS BEEN THE OUTLINE OF YOUR WORK TO DATE AND ARE YOU AT A POINT WHERE IT'S ONLY A THEORETICAL MODEL? OR DO YOU HAVE ANY KIND OF HARD EVIDENCE NOW THAT WOULD SUGGEST THERE IS SOME KIND OF ANOMALOUS PULL GRAVITATIONALLY IN THE OORT CLOUD?**

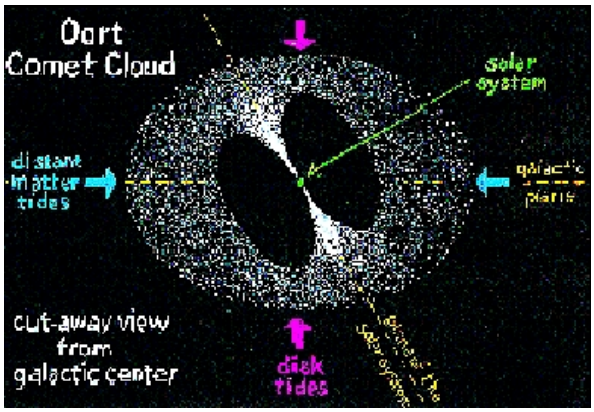
We do indeed have evidence which is the purpose of the paper we are publishing. The nature of the evidence is the comets that we see coming into the inner solar system. We only see them when they come close to the sun and begin to evaporate. These comets come from far outside the planetary region of the Solar System. They come from a region called the Oort Cloud which is tens of thousands times further from the sun than the earth and Pluto are. These comets come in on very elongated orbits.

Taking into account observational biases, one would expect comets when they come in around the sun to be roughly uniform in their positions in space. So, if you plotted the closest point of the comet to the sun on a globe or sphere, the comets should be uniformly distributed. In fact, comets are not uniformly distributed.

**COULD YOU PLEASE EXPLAIN HOW THE DISTRIBUTION OF THE COMETS IS UNUSUAL ENOUGH TO HAVE PROVOKED YOU AND YOUR COLLEAGUES TO HAVE LABORED OVER THE ISSUE THE PAST TWENTY YEARS?**

It's best to visualize it by talking in terms of the comet aphelia - the furthest point from the sun. If their orbit goes around the sun, they have very elongated orbits, not like the planets at all. So the ones that come into the solar system come from far out in the Oort Cloud, come in and go around the sun and go back again. If you put little points on a globe corresponding to the points in the sky of the comets aphelia, the furthest points from the sun, and you distribute them on a globe, you would expect them to be roughly uniform.

Since we only have a finite number of comets, you don't expect it to be exactly perfect and uniform. But you expect it to be statistically consistent with uniformity. There is a slight qualification there because the effect of the galaxy called the "galactic tide" tends to have some effects on the distribution. But we took that into account. In fact, that's one thing we did that our colleague in England, Dr. Murray, did not do. We took into account the galaxy's effect.



Drawing depicting our solar system and Oort Cloud surrounded by forces of galactic tide, courtesy NASA, 1999.

When I say uniform in the sky, that's roughly true. The galaxy produces some non-uniform distribution which we take into account. But after having taken that into account, the distribution in the sky is still anomalous. It's not what's predicted. It's not what's expected. And so, what's different is that there is a band in the sky that has more comets than you would expect. There is this great circle across the globe, it's the band, and there are more comets in that band than you

would expect to occur on the basis of statistics. A lot more. In other words, if you threw darts at a globe and asked the question: How often would you have that many comets lying in a band of 1/10th of the sky? And the answer is something like one time in a hundred to one time in a thousand. Somewhere in that range.

In summary, there are 23 excess comets in this band, over and above what you would expect. We're only analyzing 82 comets. So, out of 82 comets, about 23 of them there are 23 more than you would have expected to lie in this band.

**THIS IS WHAT CAUGHT YOUR ATTENTION AND BROUGHT THIS WORK TO THIS POINT?**
Exactly. And it caught my attention because of my previous history with Nemesis. John Matese is the expert on the galactic tide. So, he was trying to explain this in terms of the galactic tidal force - that's the effect of the rest of the galaxy on comets. He was trying to explain this in terms of the galactic tidal force and tried to do that. And I worked with him on it also. And it didn't work. Ultimately, we couldn't explain this band in the sky as being due to distant matter in the galaxy. So, we were sort of driven to this new theory of a perturber at the edge of the solar system.

You want to try all the conventional, known explanations first before you go to something that postulates something that's unknown. So, we did. We published several papers with other explanations that ultimately failed and we were sort of driven to this model that it could be explained by a brown dwarf in the outer Oort Cloud, a massive object about three times the mass of Jupiter out in the Oort Cloud at about 30,000 times further from the sun than earth is.

**IF THERE TRULY WERE A BODY THREE TIMES THE SIZE OF JUPITER OUT BEYOND PLUTO, WOULDN'T WE HAVE BEEN ABLE TO DETECT THAT BY NOW WITH HUBBLE OR WITH SOME OTHER TYPE OF INSTRUMENTATION?**
No, Hubble primarily observes in the visible part of the spectrum and near infrared. This object would only shine in infrared wavelengths longer than Hubble could see. In infrared, this object could probably be observed now. There are millions of sources out there in the infrared and you'd have to be able to discriminate this particular object from millions of others out there. That can be done, but it's not easy. It's brightness is not large. It's still extremely dim, even in the infrared. That's the only hope of observing it, in the infrared and possibly in the radio part of the spectrum.

**IT WOULD BE DIM BECAUSE WHY?**
Because it's so far away and because it doesn't shine. See, the planets in our solar system shine because of reflected light from the sun. Jupiter, for example, is five astronomical units (A. U.) from the sun. An A. U. is the earth-sun distance (93 million miles). Jupiter is just five times further away from the sun. It's close enough that there's a lot of reflected light from Jupiter.

The object we think is a brown dwarf would be 30,000 A.U. from the sun. So, even though it's somewhat larger than Jupiter - actually it's not larger than Jupiter. It's more massive than Jupiter, but for technical reasons, it's actually smaller in size. It doesn't emit light and reflects only an infinitesimal amount of light back towards the earth. So, there is no hope of seeing it on the basis of its reflected light from the sun like the other planets. A brown dwarf would be something that's between Jupiter and a star in mass. It radiates heat, but is not hot enough to be in the visible light spectrum. It can only be detected on the basis of infrared emission.

**WHEN YOU SAY THE MASS IS THREE TIMES THE MASS OF JUPITER, YOU'RE TALKING ABOUT THE MOLECULAR MATTER ITSELF. BUT IF IT IS A BROWN DWARF, IT HAS COLLAPSED ON ITSELF AND IS CONDENSED AND THEREFORE, THAT IS WHY IT IS SMALLER THAN JUPITER?**
That's true. It's technically it is said to be more 'degenerate' than Jupiter which

translates to it's more dense. If you added mass to Jupiter, for example, Jupiter would get smaller in size.

**A BROWN DWARF, I UNDERSTAND. BUT IN TERMS OF THE PAPER YOU'RE GOING TO HAVE IN *ICARUS*, IT SEEMS LIKE WHAT YOU'RE DESCRIBING IS INTERPRETATION OF SOME ANOMALIES NOTICED IN COMETS, BUT NO OBSERVATIONAL DATA AND EVERYTHING IS STILL IN THE THEORETICAL REALM?**
That's exactly right. The evidence we have is the effect that the proposed brown dwarf has on comets. This is the only explanation that we can think of to explain these anomalous distributions of comets in the sky. It's always possible there could be some explanation that we haven't thought of, but we have spent several years working on it and have published several papers trying to explain this, and ultimately they failed. The theories failed.

So, it is something we're driven to. But it's indirect, you're correct. It's an indirect prediction or evidence for the existence of this theorized brown dwarf. It's very much analogous to the discovery of Neptune. Neptune was discovered in 1846 by two independent mathematicians and astronomers on the basis of its influence on the planet Uranus. So because Uranus wasn't acting according to Newton's Laws and wasn't quite where it should be when it should be, the scientists proposed that there was another planet out there that wasn't being taken into account and it explained the discrepancies in the motion of the planet Uranus.

So, what we're doing is analogous to that. We're seeing discrepancies not in another planet, but in comets coming into the solar system discrepancies in that they are not uniform in the sky.

**YOUR HYPOTHESIS WOULD BE IF THIS BROWN DWARF IS A REALITY OUT THERE THAT IT WAS CONCEIVED AT THE BEGINNING OF THIS SOLAR SYSTEM ALONG WITH OUR SUN?**
That's what I think is the more likely scenario. It formed as a fragment of a cloud that formed the solar system. In other words, it didn't form along with the other planets. It formed separately like a star. However, Dr. Murray in England believes that it formed in a different solar system and was ejected. That's known to occur, that massive planets can be ejected from other solar systems. We see other indications of that from the extra-solar planets that have been discovered recently.

**YOU MEAN THAT THERE WOULD BE PLANETS JUST WANDERING AROUND IN DEEP SPACE?**
Oh, there are probably lots of massive planets wandering around in space, yeah. But the problem is capturing them. It's very difficult for the sun or any star to capture an interstellar planet because dynamically the physics is such that it's very improbable. It can happen, but it's very improbable. So, we prefer to believe that it formed with the sun and formed like a star and was just a failed star companion. And we base this on the analogy with binary star systems. There are lots of wide binary star systems in which you have two stars and the second star is a less massive star and it is in some cases ten thousand or more A. U. separated from its other star. So we do have examples of this sort of thing occurring with other star systems - wide binary star systems.

**IF IT WERE A WIDE BINARY STAR SYSTEM, ONE STAR SURVIVES WHICH IS OUR SUN. THE OTHER DIED AND WOULD BE THE BROWN DWARF?**
Right, the sun became a normal star and the other one fizzled because its mass never was great enough.

**FOR ALL OF THE 4 1/2 BILLION OR 5 BILLION YEAR AGE OF THE SOLAR SYSTEM, THIS BROWN DWARF WOULD HAVE BEEN IN THIS ORBIT?**
No, it wouldn't have been in this same orbit the whole time. As a matter of fact, if it started in this orbit it probably would not have survived 4.5 billion years.

So, it's more plausible that it started in an orbit that is closer in because the orbit over 4.5 billion years would be affected by other stars passing by and so it presumably would have started in an orbit at one to ten thousand A. U., initially, and it's been pumped up to its current orbit at 30,000 A. U. over 4.5 billion years.

That's the same way comets are. Comets started out closer into the solar system in the planetary region and their orbits eventually got pumped out and detached by stars and so on passing by. That's how they ended up in the Oort Cloud, I think.

**THE OORT CLOUD WOULD EXTEND OUT HOW FAR?**
Further than 30,000 A. U. The Oort Cloud extends out at least twice that distance.

**THE OORT CLOUD IS 60,000 A.U.?**
There is no well defined ending or border to it. It gradually disappears. There are comets out twice as far as our proposed brown dwarf, out to 60,000 A. U. Most of the comets we see come from the Oort Cloud.

**BRIAN MARSDEN AT THE HARVARD SMITHSONIAN CENTER FOR ASTROPHYSICS WAS ASKED TO COMMENT ON YOUR PAPER'S PROPOSED THEORY AND HE SAID, 'I AM QUITE A BIT SKEPTICAL, BUT THERE MAY BE SOMETHING TO IT.' (ANOTHER SCIENTIST) SPECIALIZING IN PLANETARY DYNAMICS AT THE LUNAR AND PLANETARY INSTITUTE IN HOUSTON, SAID: 'YOU DON'T HAVE ENOUGH NUMBERS OF COMETS TO FEEL COMFORTABLE THAT THIS IS REALLY CONVINCING EVIDENCE.'**
Well, that's a common observation. Everybody wants more data, including us. And if you're looking at something like this that is unknown, that's new, or you are proposing something that is new, almost by definition it's got to be marginal. Otherwise, it would already have been discovered. So, if the data were so good like he wants and like we want - if it was that good, this would have been discovered fifty years ago.

So, you have to work with what you have. And I completely agree. They are skeptical as they should be. But it can always be a statistical fluke. Everything we see or try to explain could conceivably be just a freaky statistical accident. There might not be any physics behind it at all. That's always possible. But, we quote statistics that say the odds of that being true are something like 1:100 to 1:1000.

We presented what we think is a strong statistical case in our paper that will be published in Icarus. And we're not going to have people like Brian Marsden at Harvard 100% convinced by our argument. What we hope is that we make a good enough case that the infrared observers will go and look for this object. That's our objective. So if we make a strong enough case then people will go and look for this brown dwarf. If it's there, we'll hopefully find it.

**IS AN INFRARED SEARCH GOING TO HAPPEN ANY TIME SOON?**
Yeah, I think the next generation of infrared telescopes in space will have the capability of seeing it. There's an infrared telescope called SIRTF that is going to be launched, I think, in two years that would easily be able to see this object.

**HAVE THEY AGREED WITH YOU OR TALKED WITH YOU ABOUT MAKING THIS ONE OF THEIR MISSIONS TO LOOK FOR THIS BROWN DWARF?**
We haven't talked with anyone on the mission yet, no. But that's the purpose of publishing the paper. If they'll read the paper, they can decide for themselves as to whether it's worth their time to go look for this object. So, that's our goal to make a good enough case that people will look.

**WHO AT NASA MAKES THOSE KIND OF DECISIONS?**
Well, the way it works there's a NASA science team which runs the experiments, is in charge of the satellites. They have certain priorities on their experiments.

It's a competitive thing. NASA alone doesn't make the decision. It's scientists, universities. There are probably more scientists in universities that observe on these telescopes than scientists at NASA.

**YOU'VE BEEN LIVING WITH THIS ISSUE FOR ABOUT 16 YEARS. IF YOU WERE A BETTING MAN, DO YOU THINK THE INFRARED EXPLORATION OUT IN THE OORT CLOUD IS GOING TO TURN THIS BROWN DWARF UP?**
Eventually if it's there, it will be discovered.

**WHAT DOES YOUR GUT TELL YOU?**
My gut tells me there's a better than 50/50 chance that it's there. I can't put better odds than that on it. All I can say is that we can't think of any other explanation of what we've observed in the comets.

**IF THE BROWN DWARF ISN'T THE NEMESIS OBJECT, WHAT IS CAUSING THE 26 MILLION CYCLIC EXTINCTIONS?**
That's a good question. That's an unanswered question. A lot of scientists, since there is not an answer, not an obvious mechanism, a lot of scientists have chosen to believe that's a statistical fluke - that there really is no 26 million cycle and only a coincidence. But there is no accepted theory now.

I think John Matese has the best theory going now to explain that cycle of extinction. It is a whole separate theory having to do with oscillation of the solar system through the galaxy. John published a seminal paper on that in Icarus a year or two ago.

**THE OSCILLATION MEANS WHAT? AND WHAT DO WE GO THROUGH THAT CAUSES THE DESTRUCTIVE PERIODS?**
The sun and the solar system as they go around the galaxy, the orbit is such that all of it bobs up and down like a merry-go-round. And the bobbing period is somewhere around 60 million years. So every 30 million years, the sun passes through the plane of the galaxy. And when it does that, there is an effect of the galactic tide - a tidal force that turns out to be important. The tidal force affects the comets in the Oort Cloud. It's like they get an impulse, they get a kick, every time they go through the galactic plane. So that kick causes some of them to come into the inner solar system that wouldn't come in otherwise. And so the net result is that you get an increase of at least four times as many comets coming into the inner solar system every 30 million years.

**THAT MEANS THERE ARE GREATER ODDS FOR ONE TO HIT THE EARTH?**
Exactly. There are greater odds for one to hit the earth.

**WHERE ARE WE IN THIS CYCLE RIGHT NOW?**
That's model dependent. In John's model, the sun is a few million years going up through the plane of the galaxy. So, in that model, the comets are already heading inward. They haven't gotten here yet because it takes millions of years for them to fall inward from the outer Oort Cloud. In other words, once they are perturbed in their orbits by the galactic tide, then it takes several millions of years to fall into the solar system. This would be in the future a couple million years, the best I understand it. And if there is an impact, the impact of a large comet it would probably be from the comets in the outer Oort Cloud which seem to be faster and have more energy than the local comets. And a large comet impact would have a huge effect on earth. The best documented one, of course, is the Cretaceous/Tertiary impact that occurred 65 million years ago that lead to the end of the Cretaceous geological period and the beginning of the Tertiary period. The impact wiped out dinosaurs and two-thirds of all species on the earth. It's known as the 6th mass extinction event.

**IF THAT HAPPENED 65 MILLION YEARS AGO AND WE'RE IN SOME 60 MILLION YEAR CYCLE, ARE WE FIVE MILLION YEARS PAST ANOTHER COSMIC CATASTROPHE?**
Even though there is a period there, it's not a precise period. This is all statistics. You're more likely to be hit by a big comet if there are more big ones coming

into the solar system. If coming in at increased rates for periods of millions of years, that just means you're probability is up over those several million previous years. You can't narrow it down to the level that the earth is likely to be struck at a specific million year period.

**BUT WE WOULD BE AT THE END OF THE 60 MILLION YEAR CYCLE NOW IN WHICH THE LIKELIHOOD WOULD BE THAT WE'RE GOING TO HAVE MORE COMETS?**
Yeah, the likelihood would be that there are going to be more comets coming."

**Credits**