

Hale-Bopp Object

by

Sam Aurelius Milam III
c/o 4984 Peach Mountain Drive
Gainesville, Georgia 30507

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caveat lector

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Author's Note, Thursday, September 10, 1998:

I wrote this essay while the Hale-Bopp object was still a long distance away. In the essay I suggested that the Hale-Bopp object might not be a comet, as most people believed. When it went past, it looked a lot like a comet. Oh well, it's still an interesting essay.

I'd like to speculate about the Hale-Bopp object. Actually, I'm speculating with very little data. I may well be forced to change my ideas as more information becomes available to me. Nevertheless, here are my thoughts at this time.

The Hale-Bopp object has been designated as a comet. That could be an accurate conclusion to draw from the available description of it. However, when I first heard the object described, it immediately occurred to me that the description might lead to other conclusions. The description, as I presently understand it, is that the object is 100 to 150 kilometers in diameter. According to rumor, it's trailed by a tail that's dispersed to a diameter of about one million miles. The perihelion of the object is expected on April 1, 1997. At its closest approach to the earth, the object is expected to pass within Earth's orbit and to be a scant 1.3 astronomical units from Earth itself. That's less than 120 million miles. I also heard somewhere that a large object, perhaps one third of the apparent diameter of the main object, had been observed to detach from the main object. I'm not aware of the accuracy of that report. However, I'm also not aware of comets exhibiting such behavior. When I first heard the Hale-Bopp object described, the idea that came immediately to mind was that the description could just as well be that of a vehicle with a light sail deployed behind it. While this idea is admittedly unconventional, I don't think that anybody can make an authoritative denial of the possibility of an interstellar vehicle approaching our solar system. Therefore, I feel free to speculate.

Such travelers approaching our solar system would naturally want to learn as much as possible about the system as early as possible. By the time that they were within planetary range, they would have been studying the solar system for a long time. Indeed, our own radio signals have now traveled almost 100 light-years distant, giving any approaching travelers a lot of food for thought. The mobilization of an auxiliary vehicle, enabling the group to explore different portions of the solar system, would be a reasonable plan and would explain the smaller body that was detached from the main body. It would be advantageous to launch such an auxiliary vehicle as early as possible during the approach to the system. Indeed, that might not even be the first such vehicle that they have launched. It might just be the first one that we have observed.

The thought of auxiliary vehicles leads to questions about the main object. That object might not necessarily be spherical. We might be observing the end of a long stack of disk-shaped cylinders. The travelers could deploy units from the stack at

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need without changing the projected frontal area, which is the round shape that we observe from our angle of view. A vehicle made of a stack of disk-shaped cylinders has the advantage that it would be much easier for such a vehicle to be modular. The travelers might build modules as they travel and leave entire self-supporting assemblies in solar systems through which they travel. That shape also lends itself to spinning, with all of the advantages provided by centrifugal force. The only advantages of a spherical shape are those associated with minimizing the ratio of surface area to volume. Those advantages might not be as important as others associated with the convenience of other shapes. After all, we don't build spherical houses, in spite of the thermal advantage that it would provide during the heating season.

If we assume the object to be spherical, then we have all of the dimensions necessary to estimate its volume. If, however, it's a cylinder viewed end-on then we can only speculate. In either case, the size of the object makes it large enough to be a generation ship. Unless the travelers have some sort of cryogenic suspension or inordinately long life spans, a generation ship would be necessary. That's true because a vessel powered by a light sail would probably not be very fast. It would take many generations to complete an interstellar voyage. The ship would need to carry not a crew, but a sustainable society.

The reflectivity of the trailing portion of the object, according to the rumors that I've heard, is relatively low. That can be explained variously, assuming that what we see is indeed a deployed light sail. Reflectivity of a light sail might be controlled in any number of ways. Maybe they use something analogous to liquid crystal and simply vary the applied voltage. They might simply rotate sections out of alignment. They might disburse a volume of opaque gas ahead of their vehicle. You can probably think of other methods that would work and the travelers can probably think of even more.

There might be any number of reasons why they would want to reduce the reflectivity of the sail. The first thing that comes to mind is that newcomers might think it prudent to look like a comet when approaching a new solar system while at the same time keeping their sail deployed. A light sail that can be focused would be a powerful defensive weapon, at least near a star. Another reason for the present low reflectivity might be that they are not yet ready to begin deceleration. They might have deployed their sail and given it sufficient reflectivity to keep it deployed without significantly effecting their course. Yet another possibility is that the sail is indeed fully reflective but focused precisely on energy collectors. All that we see is the stray reflection resulting from a less than perfect surface.

The object is, as I previously mentioned, expected to pass within about 1.3 astronomical units of the Earth. The estimated time of the closest approach is April 1, 1997. That assumes, of course, a free fall trajectory. However, the object is approaching us very nearly head-on and it is a long way off. I wonder if astronomers

have yet been able to determine whether or not it is actually in free fall. It might, instead, be decelerating. Even if it isn't presently decelerating, it could begin doing so at any time. Any departure of the object's trajectory from free fall would suggest controlled flight. In that case, the variations in the trajectory might suggest a lot about the intentions of the hypothetical travelers. If they don't like what they see here, then they might prefer to simply fall through the system as quickly as possible. Members of a society that has already spent generations in such a vessel might be entirely willing to pass by a solar system which promised a hostile reception. They could simply continue their accustomed lifestyle and let their descendants continue the search for greener pastures. On the way by, they might modify their trajectory with some other destination in mind. A light sail probably doesn't provide a lot in the way of maneuverability. However, by optimizing course deflections caused by the gravity of other bodies in the solar system, the travelers might accomplish such a thing. In fact, other massive "throw-away" portions of the vehicle already deployed could be intended to make close passes by other bodies in the solar system followed by close passes by the main body. The travelers could thereby use momentum acquired from other bodies in the solar system to deflect their vehicle's trajectory without even passing near those other bodies. The vehicle might even be propelled by other means of propulsion that could be powered by a light sail.

They have other options. They could modify their trajectory into a highly elliptical orbit that would pass near to the Earth but require hundreds or even thousands of years to complete. On the way by the Earth, they could rid the planet of our presence. If their light sail can be focused, then it is a formidable weapon when it is this close to the sun. Depending upon the extent of their information about us and their ability to focus their sail precisely, they might leave the planet in whatever condition they believe will best optimize the situation at the eventual return of their descendants. Depending upon their nature and their interpretation of what they observe, such a plan might seem reasonable to them. Yet another option would be to park their vehicle in a convenient location and initiate trade. Such an actual "landing" in our solar system would, of course, mean that they'd arrive substantially later than 1997, due to the increased travel time caused by deceleration.

I don't know with certainty that a light sail will provide thrust over an adequately long range of distance from a star for it to be useful for interstellar propulsion. I believe that it will, but it isn't my field. However, even if a light sail will not generate significant thrust over a useful distance, it will provide a method of concentrating and accumulating energy over a considerably greater distance. That energy might be used to operate or augment some other method of generating thrust. Assuming for the sake of discussion that a light sail will work over a useful range of distance from a star, an auxiliary source of additional thrust might still be convenient during the vehi-

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cle's launch. Thus, a vehicle that accelerates using a light sail might have been launched by a battery of laser cannon mounted on planetary surfaces or by a flotilla of orbital auxiliary sails used to focus additional light on the propulsion sail. Either method has the advantage that the auxiliary engine doesn't have to travel with the vehicle and therefore doesn't add to the mass that must be accelerated. It must be taken for granted that light sail propulsion means very slow trips measured in great lengths of time. For trips to undeveloped areas like our solar system, deceleration at the destination will be limited to the rate that can be achieved by the light sail. There are no laser cannon here for braking. This might require several passes through the system with the first pass succeeding only in reducing the vehicle's velocity below escape velocity and thereby modifying the vehicle's trajectory into a long elliptical orbit. I've already mentioned ways that course deflections using the mass of other bodies could assist the process.

The lack of laser cannon for braking raises other implications. If the hypothetical travelers decelerate to below escape velocity while they're within our solar system, then they'll be here for a while. Whatever auxiliary engines they might have used to launch their vehicle don't exist in our solar system. I suppose that they could depart from the solar system by alternately enabling and disabling their light sail in a highly elliptical orbit. By falling past the sun as close as possible at each perihelion, they could obtain maximum value from the light sail for the outward bound leg of each orbit. By doing that, they could gradually elongate their orbit until they escape. However, that would be a long and tedious process. They could end up in an elliptical orbit taking thousands of years to complete before they could try again for escape velocity. There is an alternative. In our solar system there are planetary surfaces, a lot of resources, and plenty of cheap labor. Since the hypothetical travelers already understand the technology, it would be faster and easier for them to utilize the local resources to build another battery of laser cannon or another flotilla of orbiting light sails. Hopefully, they'll be civilized about it. However, if they just take what they want from the natives (us) and force us to do the work for them, then I think that it would be hypocritical of us to complain. After all, such action would be in the long tradition of our own past behavior.

The hypothetical travelers might have left an intact civilization behind, manning their launch infrastructure. In that case, there could be other vehicles following behind this one. Or, they might have taken their entire population with them and controlled the launch remotely, from the vehicle. In that case, this will be a lone vehicle.

Admittedly, this is all pure speculation. Additional data may prove my ideas to be entirely untrue. However, I believe that there's virtue in speculation, however unconventional the subject matter. Even if I'm wrong about the Hale-Bopp object, the exercise in speculation is still worthwhile.