Speculations on Negative Mass

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The curvature of the universe is the opposite of that predicted by general relativity. Specifically, general relativity produces a universe with a center and edges. The "closed universe" is really only closed in time unless the mass is great enough to bend light back on itself, which would make the universe a black hole. To give the universe the correct curvature, it is necessary that the universe have a net negative mass.

Unlike antimatter, which releases energy in the form of gamma rays when fused with regular matter, when negative matter and regular matter fuse they just disappear. It is also possible that matched particles would start to chase each other at speeds approaching light. In any case, for the net mass of the universe to be negative, symmetry is broken.

One possible explanation is that negative mass does not form particles, but rather is distributed evenly throughout space. (Positive mass forms particles, negative mass forms universes.) In fact, creating enough negative mass to form a universe should release the energy needed to drive the big bang. Since a small universe is more tightly curved than a big universe, one could argue that the expansion of the universe is driven by the conversion of energy to matter. A flat infinite universe is the end state when all the energy released by the big bang is converted to matter and the net mass of universe goes to zero.

The big question is whether it is possible to concentrate and contain negative mass. While a centrifuge forces positive mass outward, one would expect negative mass to be pulled inward. Since a spinning mass pulls space along with it, any spinning cylinder should work, although one with millions of tiny radial tunnels might work better. It should be noted that concentrating negative matter will consume energy.

As measured by collision cross-section, matter is largely empty space. However, on a quantum level size and location are almost meaningless. In terms of their Schrodinger wave solutions, atoms are packed cheek to jowl. So it is possible that negative mass might regard solid matter as an impenetrable barrier.

Let us also assume that negative mass actively avoids gravity wells, so that negative mass concentration is restricted to deep space, possibly with factories in cometary orbits.

The principle use of negative mass would be canceling inertia. The energy required to drive a ship weighing only a few grams is easily stored, with the biggest problem being to keep the ship's mass above zero for the whole voyage. Photon drive is almost a necessity, and the low forces needed might be achieved by an array of LEDs.

The "tanks" containing negative matter will exert large forces on the rest of the ship and require strong bracing. Springs and shock absorbers would also help so that small collisions would be absorbed by the hull and not kill the crew with G forces. If negative mass behaves like an Bose-Einstein condensate, one would only need a very small container. If negative mass behaves like a gas, one could achieve the same effect as shock absorbers using multiple tanks connected by pipes and using baffles or turbines to dampen the oscillations.

Landing on a airless world or spiraling into a spinning station would be relatively easy, but landing in an atmosphere would be very difficult. A ship containing negative mass would fly sort of like a dirigible, only lighter. Either they would need to load up with ballast each trip down or use large fans to force their way to the ground.

Alternatively, negative mass makes a practical "beanstalk" possible. Instead of stretching beyond geosynchronous orbit, the top would only need to be high enough to allow low-mass ships to dock. Nor would it have to be located on the equator. Distributing negative mass along the cable/tower would enable it to float like a balloon if severed.

Even at a constant 1G acceleration, it would take 35 days to reach a velocity of $0.1c$. Suffice it to say that higher acceleration would significantly reduce the travel time for interstellar voyages, so cargo ships run by AI would have an advantage over passenger ships and human crews. In any case, far more shipping

will be interplanetary than interstellar.