

Physics of Interstellar Propulsion

by Dr. Michio Kaku

Henry Semat Prof. of Theoretical Physics, City Univ. of New York

www.mkaku.org

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**The Potential for Interstellar Travel and Unidentified Aerial
Phenomena**

Science Fact or Science Fiction?

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The speed of light is a daunting but not necessarily insurmountable challenge to any star-faring civilization.

The physics of interstellar propulsion depends crucially on the available energy source.

Physicists, when cataloging potential civilizations in outer space, often rank civilizations according to their energy output on the Kardashav scale:

- Type I (which harnesses the energy output of an entire planet)
- Type II (harnessing the energy output of a star)
- Type III (harnessing the energy output of a galaxy).

Each civilization type is separated from the previous one by a factor of about 10 billion.

By contrast, our present civilization is Type 0, which harnesses the energy output of dead plants. Growing at a modest 3% per year, we are about 100-200 years from becoming Type I, several thousand years from attaining Type II status, and perhaps several hundred thousand years to a million years from reaching Type III).

On this energy scale, various civilizations might exploit the following modes of exploration.

Type 0

- Chemical rockets
- Ion rockets
- Atomic rockets

Type I

- Fusion/Ramjet propulsion
- Laser propulsion

Type II

- Anti-matter propulsion
- Nano/von Neumann probes

Type III

- Planck energy propulsion

According to Special Relativity, no usable information can locally exceed the speed of light, hence Types I and II civilizations can only explore near-by stars. However, according to General Relativity, objects can exceed the speed of light

globally if we use global distortions of space and time (e.g. the Big Bang expanded much faster than light) and multiply connected spaces (e.g. wormholes). Although there are hundreds of solutions of Einstein's equations which allow for such distortions, there are two limiting factors:

- a) quantum corrections may destabilize these anomalies
- b) the energy source necessary to drive these systems is the Planck energy (i.e. 10^{19} billion electron volts, the energy at which space and time becomes unstable, and virtual universes might become real).

In the first case, superstring theory (M-theory) is on the verge of giving us a calculable quantum theory of gravity and may settle this question once and for all.

But in the second case, only a Type III civilization may be able to harness this mode of propulsion (using large quantities of either positive or negative energy in the form of zero-point energy).

Thus, if we ever encounter a civilization capable of leaping into 11 dimensional hyperspace or punching a hole in space-time, we can safely conclude that they are a Type III civilization, hundreds of thousands to a million years ahead of us in technology.