Re: Solar powered lasers in space

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- *From*: Ian Parker <ianparker2@xxxxxxxxx>

- *Date*: Wed, 19 Sep 2007 03:42:12 −0700

On 18 Sep, 19:05, Willie.Moo...@xxxxxxxxx wrote:

> On Sep 18, 11:56 am, Ian Parker <ianpark...@xxxxxxxxx> wrote:
>
>> One further point on phase mirrors. They will not work in deep space.
>> In the case of an asteroid one wouold have to have a pilot spacecraft
>> where the Asteroid will be a double journey into the future.
>>
>> − Ian Parker
>
> On my google groups tree this is response 41 when sorted by reply, and
> for the life of me I cannot bring up response 40 − so I don't know
> what to say there.

I'm sorry. I had that rather as an afterthought. The pure phase mirror
will work only for stationary targets. For targets aroung the Earth
you have about 1/3 sec. For the asteroid it might be up to 1hr.

> Beaming a tiny spot to an asteroid is a matter of figuring out the
> wavelength and the Rayleigh criterion. The assertion you make here −
> and the conclusion − doesn't make any sense − so you've missed
> something friend.
>
> If we are to seriously consider asteroid capture, or its twin,
> asteroid deflection, using sunlight, then we need lots and lots of
> power. That means we'll have to dip in close to the sun − this is
> several powersat generations away − and it won't be the first thing we
> build. But we WILL use micro−nuclear triggered fusion pulse − to get
> rid of nuclear materials relatively cleanly − in a variety of ways in
> space − one of which is to develop techniques of moving asteroidal
> materials swiftly around the solar system.

I don't think I have missed anything. At 200m km you have 2*10^11 wavelenths. This means that 1.22d1.d2= 2*10^11 wavelengths or 2.44*10^5m^2. If we focus a 10m beam on asteroid this gives us a diameter of 2.44*10^4m. 24km. Is that possible. One point which is often missed when discussing this is the fact of phase coherence across an array. This is really the point I am trying to get across.
If you have a single laster with a 10cm mirror that will extend to 500m at 42,000km. If you have a phased array however you can focus onto points < 1m in size.

> Consider though in the far future, a thin film automated system of cells, that use a combination of solar wind and light pressure to navigate to a region inside the orbit of Mercury. These cells − manufactured and sent into space − operate at a relatively high temp, and so can withstand being a few million km from the surface of the sun. They are stationary held above the sun by a combination light pressure and solar wind. The cells join together to form a mat − by self−assembly − and they coordinate with each other by all seeing the same reference laser from the target − beamed from anywhere in the solar system. In this way laser emitters several hundred kilometers across − operating at 1 MW per sq meter or more − can be contemplated.
>
> Forward contemplated using fresnel lenses to collimate large solar pumped lasers − in the TW range − to project light efficiently to laser light sail spacecraft.
>
> Here, we are using advanced laser beaming technology at the emitter itself, combined with very large structures, located close to the sun, to produce similar beams.
>
> sin theta−r = 1.22 * lambda / diam
>
> where lambda = 1 micron (1e−9 m)
> diam = 20 km (2e4 m)
>
> so, sin theta−r = 6.1e−14
>
> Now, a spot 20 cm in diameter can be formed 1.2 billion km away.from a 20 km diameter emitter using 1 micron wavelength radiation. Emitting 1 MW per sq m − a 20 km diam disk emits a total of 314 TW. This heat source operating a thermal rocket having an ejection speed of 10 km/sec − can produce a steady thrust of;
>
> F = P/(2V) = 3.14e14 / (2*10,000) = 15.7 GN = 1.6 million metric tons force
>
> So, a spherical mass of 1 km with a density of 2 g/cc − has a mass of 8 billion metric tons. − and can be accelerated continuously at 7 m/s per hour. (1/5000th gee)

> To impart a delta vee of 7 km/sec (which is typical of moving an object from the asteroid belt) requires 1000 hours of illumination by this source. 8 objects per year can be handled by this single source − harvesting 64 billion metric tons of material into MEO each year − 10 tons for every man woman and child on the planet.
>
> Since the asteroid itself is ejected as the rocket exhaust − we can estimate how much of the asteroid will be used up;
>
> u = 1 − 1/exp(7/10) = 0.5034 = 50.34%
>
> About half.. part at the outset, part when braking into Earth orbit.
>
> So, 5 tons for every man woman and child on the planet.
>
> First, there would be a survey of all the small bodies inthe solar system, and then they would be rated for their value. The highest value objects would then be harvested.
>
> While the survey is going on the sun−centerd solar powered laser system is built.

Of course we do everything in parallel. We are looking at orbits as of now. As I said in my first contribution to the thread on the NASA report, a laser system would determine the orbit more precisely, give greater warning and add up to a far lower delta v.

> The solar powered laser then beams energy to a manned spacecraft that travels to the asteroid, and erects a solar powered thermal rocket describes − it also uses laser energy to process the asteroid into portions to keep and portions to eject in the rocket.

The idea of a nuclear bomb is that it vaporizes the surface thereby proving a small delta v. A laser would essentially do the same thing but act over a longer time period.

> A small safety team stays on the asteroid, riding it back to Earth on a minimum energy orbit − and making sure all system operate as planned − and the main spacecraft, goes to the next target.

You don't send it back to Earth, you simply deflect it so that it goes close to the Earth but does not collide. That is the basic idea.

> Five years − R&D − Five years construction − Five years − mission.

> A five year mission − haha− would collect 40 asteroids totalling some 160 billion metric tons of highly useful materials into MEO.
>
> Those asteroids would then be processed by orbiting factories − solar powered of course − via telerobotics (light delay negligible) − which then deorbit products directly to users on Earth − or deliver them anywhere in the cislunar system they're needed.
>
> This will form the basis of the first space farm, and space home developments. And support the large scale movement of people off Earth into space − aboard their own space colonies.

This sort of scenario provides a way of gradually building up. In any project you need to have intermediate stages or it wil never be built.

As all of you are probably aware my "hobbyhorse" is AI and robatics and there seems little doubt that a solar complex would rapidly develop into a Von Neumann complex in the way that you suggest. I thought at one point that a VN machine would be needed to build lasers. If you have a carbon slurry in liquid hydrogen and low launch costs this may not be the case. Any engineering on asteroids has to be thought of in a Von Neumann context.

− Ian Parker

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