Re: Solar powered lasers in space

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- *From*: Ian Parker <ianparker2@xxxxxxxxx>
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On 19 Sep, 15:30, Willie.Moo...@xxxxxxxxx wrote:

> 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.

Please point to what you're talking about. I see the 1.22 factor in there, so it looks like Rayleigh limit,

The 10m spot on the asteroid is at the first minimum of a circular aperture. It is Rayleigh,

But I divide, not multiply to get the Rayleigh limit

sin(theta−r) = 1.22 lambda / diam
= 1.22 * 1e−6 / 24e6
= 5.083e−14

You multiply to get the apeture.

And the radius around the center line of the Airy disk at a range of 200 million km from a 24 km diameter emitter you have;

R = 5.083e−14 * 2e11 = 1 cm

24km 1.22lambda/d radians or 1.22/24*10^9 or 5*10^−11 radians = at 200million km or 200*10^9m or 2*10^11m 2*10^11 * 5*10^−11 = 10m

at 20 billion km

R = 5.083e−14 * 2e14 = 1 m

> I think we're talking past each other. I should have said, I missed what you were saying...

I think you are right. I think too we were talking about different things. NASA was talking about planetary defense. You are talking about using asteroids.

> A laser film with active optical film layered together − responding to a 'seed' to use your terminology AT the target − emitting 1 MW or more of laser energy per square meter is what I'm talking about. Several of these films operating together to form an array of phase controlled elements 20 km wide or more is what I'm talking about.
>
> Now, what's the commercial value of this infrastructure? The answer obviously is to gather the riches of the solar system to bring back to Earth and its people to use commercially. And payback with some return the folks who put the money into building it in the first place. As a side benefit, all the objects in the solar system will have been surveyed, and all the objects that will collide with the Earth will be deflected − a new epoch will have arrived for the people of Earth.

This is true.

> > One point which is
> > often missed when discussing this is the fact of phase coherence across an array.
>
> Right. That's the point of the pilot beam from the target. You can set it up so that a 'seed' beam as you called it, could be used as a reference. Basic holography really − and that reference could direct the energy to another point. But to my way of thinking a pilot beam FROM the target is a simple solution. The ability to direct the beam elsewhere −other than where the pilot or seed beam comes from− and change its phase across the surface− can be used for a wide range of applications though − and I do have a notion how this can be used to provide some interesting safety and reliability features going forward. Even to charge customers for their power use! lol.
>
> > This is really the point I am trying to get across.
>
> This is an important point. It lets you use flexible films and yet coordinate their actions as a single device. It also lets multiple

emitters act as a single device as well. I think I wasn't clear that the pilot beam concept I spoke of decades ago is precisely this.

> 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.

What are you saying here?

1.22 lambda / diam = 1.22 1.0e−6 / 1.0e−1 = 1.22e−5 = sin theta−r

R = sin theta−r * 42e6 m = 1.22e−5 * 42e6 = 512.4 m

This is the Rayleigh limit for a 10 cm diameter system. 1 m is far smaller than this. So, you are saying that an array of points with phase control can exceed the Rayleigh criterion!

So I must ask. Do you have any references for that? Pointers to peer reviewed papers and such?

I'm really not tracking what you're saying because in this instance you're saying you can do better than Rayleigh tells us, and above you're saying we do considerably worse.

So, a pointer to your source material would be great. I'll study it and get back with you.

> 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.

Correct. You are doing something much more limited than I am suggesting. You are looking for small bodies from Earth and then beaming energy to asteroids that will one day strike the Earth − from Earth based lasers − as they approach.

> 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.

Correct. A shaped nuclear charge that vaporizes a well defined region. The energy in both cases are comparable however.

> 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.

That's YOUR idea. And it has ZERO immediate economic utility. It avoids disaster sure, so it does have some utility and is worth doing − like paying your insurance premium. Actually better than paying your insurance premium, it avoids disaster. But MY idea is to take it up a notch. Build an infrastructure than can RETURN RICH ASTEROIDS TO EARTH ORBIT − they don't hit the Earth either. They enter a controlled well defined polar orbit. Once there, they are visited by private developers who have paid for the right to build solar powered factories that extract the material process it in space using sunlight as an energy source and return the processed material to customers anywhere they are found in the solar system. But principally to Earth. The same technology that brought us JDAMs can also bring us low cost entry carriers that deliver products made in space precisely to customers anywhere in cislunar space.

This could be done in an unpiloted mode − but that would be after extensive testing and a few successful piloted missions.

This is the basic gravitational well concept. Asteroids do not have a well.

If you do this there is one thing for sure. Ion drive will be able to reach anywhere in the solar system fast and cheaply. Also here a reminder of the Forward interstellar proposal may not be out of place here.

Of course the interesting fact is that a Forward probe (interstellar) is going to be the end result. However there are a lot of intermediate goodies in what you propose, so the chance of it getting off the ground is increased.

> 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.

You have to have the prospect of immediate returns or you will be left hat in hand begging the government to give you the money. Large resources are routinely developed by humanity. Look at large undersea oil and gas reserves. Tens of billions of dollars are spent by major companies over decades to develop the technology and bring the resource to market. Provided they have a clear ownership right, and a clear idea of what sort of value they're creating.

> Telling folks that you will avoid a catastrophe that might happen in the next 65 million years − doesn't get anyone off the dime either. Saying something bad could happen in the next 100 years − doesn't do much either.

65 million years ago it was really big. There have been a lot of impacts since, not quite so big. Spephen Hawking says we should go into space to safeguard the Earth. Risks fall into two categories. There are the natural risks 65 million BP and all that. Also Yellowstone and other surpervolcanoes have erupted fairly regularly. In fact if you had mirrors which could direct sunlight directly onto the Earth you will recover far more quickly from a Yellowstone event.

There are the political and military risks. To me going into space because of "political" risks is not a sound policy − if nothing ellse for the simple reason that space will not solve the problems and could easily make them worse.

In fact dangerous events occur far more often than once every 65 million years.

> But if you can prove to folks that − lookee here − here is a list of strategic materials that is important to the industrial development of Earth. Here is the rate at which we use these materials today. If a world of 10 billion people had a per capita use rate equal to that of every American − here is what would be needed. There is a huge difference. Lets remove the military infrastructure to revise some of them downward.

And some of the existential risks. The question of military expenditures, and the fact that the peoples on Earth are unable to live together, is something profoundly worrying. Space alone will not solve it.

> There's still a huge shortage. Where to get it? Now show them some spectra of asteroids that indicate its out there. Show them some photos of asteroids. Show them pictures showing the orbits of 30,000 known small bodies. Show them estimates of the actual numbers. Then show them you can retrieve all the strategic material industry will need for the next 100 years − within 15 years − by funding a program today − and with 50% ownership − they'll make 30% per year return compounded... and they'll be able to diversify their risk and earn profits on their investments in as little as 5 years when the whole thing is at a stage it is bankable and listable.

> 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.

> Yes. That's a whole 'nother kettle of fish and tying the two technologies together merely delays the day it arrives. Sort of like AND gating all our technologies haha.. When EVERYTHING is done, we'll be in heaven! lol. Well, lets see what we can do now?.

I do not think so. In fact I think that such a program will "sleepwalk" into VN. Non Neumann himself postulated a robot with a fuse which would put fuses into all the other robots. This is replication at its simplest! I feel that a flatpack assembler will make a VN machine inevitable.

> I've spoken to some folks who have built high−velocity guns and rail guns and they believe we can do a lot with off−the−shelf technology. Gerald Bull and others have felt since the 1960s that we could shoot stuff into orbit. We could build laser elements TODAY and shoot them into space very cheaply with cannons at 5,000 gees. We could do it with Earth based lasers as well − 5 gees to 50 gees − depending on the size of the system and what you're sending into space. But whether you settle on rail guns, super−cannons, or laser propulsion − you can send lots of 100 kg payloads off world very cheaply − and feed the launchers with a factory that churns out your basic laser element. This can be done today.

I think the best way to get lasers into space fairly short term is to use them as your "cheap" launch system. What in fact would be needed is experiments on liquid hydrogen and carbon.

> Then, once you have your laser element navigating above the solar surface − beaming TW of energy under your radio command.. then you can launch a survey ship that uses that energy to zip around the solar system to check out candidates that you have already identified. Then you process the asteroid using the laser into stuff you want to keep, and stuff you want to eject. And ferry the stuff back to Earth orbit.

> If you have a carbon slurry in liquid hydrogen and low launch costs this may not be the case.

> Well this is an interesting technology − but super−cannons have already been built, though none have yet attained orbit, they are certainly capable of it. Rail guns too are capable of it. Laser propulsion − more speculative − should be capable of it, and since we're postulating super lasers, it makes sense to put that in the game plan.
>
> > Any engineering on asteroids has to be thought of in a Von Neumann context.
>
> Why? You just said that if we had low launch costs that would change.

I think you will sleepwalk into it. If you build more lasers out of asteroid material you are probably pretty close. If you want a large array you still need space manufacturing. You will find yourself creating everything except perhaps for the really sophisticated chips.

> In fact, you could create small 10 kg to 100 kg robots launched by the same cannon as the solar pumped laser. These solar powered robots use solar sails to fly to the asteroids − and call in laser blasts from the solar laser when they're done sorting through the asteroidal material. We build them by the millions in factories right here on Earth and launch them by the millions with rail guns or laser launchers.. and they spread throughout the solar system − processing the richest asteroidal materials − readying them to be brought back to Earth orbit.
>
> These are automated − sure − but they're not self−reproducing. So, they can be built today.
>
> A $50 million study − resulting in a couple of factories costing a few billion dollars each, and a launcher infrastructure costing the same, and an operating budget of a few billion a year to build the solar laser elements and the asteroidal crawlers − and in 10 years the first material will be arriving in polar orbit above Earth. Then, development rights are sold, along with transfer to the orbiting bodies.. remotely controlled factories provide employment for everyone on Earth, and everyone on Earth receives products delivered directly from space factories that fly overhead twice a day.

Providing employment in an increasingly autmated age is going to be a major problem. Perhaps at some point coal will have to be painted white.

> During the solar system wide survey that supports this effort there are noted orbits of objects that will one day collide with Earth. These are deflected to safer orbits − as a public service.

− Ian Parker

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