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CAN WE AFFORD AN INTERSTELLAR FLIGHT?

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Abstract. What is a price of interstellar flight? How are we prepared for such grandiose task? Let me sum up main costs for three projects. We calculated only the most basic things, a price of building the sail and energy to power the laser system. We can see that only one adjusted system has a chance to be financed.

1. INTRODUCTION

For 1000 kg probe and sail (Forward 1984) sent to next star price of electrical energy for powering 65 GW laser per three years is today's 85 billion of dollars at 5 cents per kWh (Forward 1984). It is not clear how much electrical energy we need. If we assume one-third efficiency this increase our energy bill to 255 billion dollars just for price of energy, not for the power plants which can cost additionaly up to 200 billion dollars. We estimate based on United Launch Alliance's costs for Atlas V551 rocket (United Launch Alliance) for 560,000 tonns big Fresnel lens in Sun's orbit 16 trillion of dollars to build and launch it. Building and launching solar sail with probe around Sun another 100 billions of dollars based on costs of International Space Station (Lafleur). For other two flight proposals in (Forward 1984), we do not know how they can be performed with a big time delay due to huge interstellar distance. These all add up to approximately 17.5 trillion of dollars. Producing, launching and financing 100000 rockets do not seem feasible for our Earth's economy.

For Breakthrough Starshot (Lubin 2016) main expense is a cost of propelling small sail for up to four hours (Kipping 2017a). Power generation and storage at the launch site is the challenge. Developing a site with adequate infrastructure to generate the energy at a high altitude site is difficult. In the project, they claim: "Generating 100 GW class of power and delivering for several minutes at a low price is achievable with the currently available technology. Natural gas-fired power plants can generate this power easily at a price of less than 10 cents per kWh." This power needs to be delivered and stored. Relatively low cost is $ 1200 per kWh for energy system from the paper (Lubin 2016) which amount up to 360 billion dollars if we assume the same one-third efficiency. It is significantly smaller for (Kipping 2017a) but in latter version (Kipping 2017b) author included divergence of laser beam and more efficient coating, power is revised to 500 GW which amount up to 50 billion of dolars just for storing enough energy for 10 minutes and the same one-third efficiency. We estimate power generating station up to 2 GW and filling time about 48 hours. Technology and costs for conectors for such huge energy transfer in short period of time is not the aim of this paper as well as lasers.

Setting up a dedicated electricity generating system, energy storage and then using it only once for 10 minutes is obviously a bit pricey. A possible solution is to send a fleet of postal card size probes one every third day. Also, the problem is to build enough small radioisotope thermo-electric generator.

Sending solar sail proposed in (Heller & Hippke 2017) is not feasible in one man's life. Authors underestimated the thickness of the reflective coating. Covering 10^5 m^2 graphene mono-layer sail with one adsorbed He atom per heksagonal cell amounts to 12.4 g and this will not increase reflectivity enough. The cost of building such big sail in space we cannot estimate, but it cannot be less than 100 billions of dollars. Also, the problem is to build a radioisotope thermo-electric generator which will provide energy after longer time needed to sail to next star.

We can see that only system proposed in (Kipping 2017b) has a chance to be financed if we really can produce 500 GW laser. This is not too big amount of money to be spent by government with a sense of economic responsibility.

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