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FEATURE

Reaching for the stars: The case for cooperative governance of directed energy technologies

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ABSTRACT
The kind of advances in spaceflight envisioned in the mid-twentieth century have largely failed to materialize, thereby limiting space exploration to relatively small areas of a very large galaxy. That will change with the advent of directed energy technologies, specifically laser propulsion. The privately funded Breakthrough Starshot program is already working on such a propulsion system to carry nanosatellite Star Chips to the nearest star system, Alpha Centauri. But powerful lasers – a dual-use technology much like rocketry, nuclear energy, and cyber technology, which have both security-related and civilian uses – have been largely stigmatized as weapons. While security concerns about the use of large lasers are certainly justified, the development of Starshot and other big, multinational science programs can have positive national and international outcomes. Therefore, the use of a large laser array as a propulsion system will require, much like other large multinational cutting-edge science programs, a negotiated, cooperative governance system. Those negotiations should begin soon.

KEYWORDS
Alpha Centauri; Breakthrough Starshot; directed energy; lasers; NewSpace; SpaceX

In 2019 the United States Army announced its intent to build a 250- to 300-kilowatt laser weapon, called the Indirect Fire Protection Capability-High Energy Laser (IFPC-HEL, pronounced "if pick hell"), which would be 10 times more powerful than the most powerful existing laser weapon, the US Navy's Laser Weapon System (LaWS). Though reportedly never used in action, LaWS is considered to be capable of blinding enemy sensors, shooting down drones, and disabling and damaging boats and helicopters (Mizokami 2019).

In military parlance, LaWS and other directed energy weapons – a category that includes lasers, microwaves, and particle beams – are considered to be disruptive technologies, meaning they are game changers that can radically alter the symmetry between competitors (Brimley, FitzGerald, and Sayler 2013). Directed energy technologies have also been stigmatized as weapons by their decades-long depiction in popular culture (for example, in the *Star Wars* film series).

But lasers are a dual-use technology, meaning that they can be used for both civilian and military purposes. When used for civilian purposes, disruptive technologies can be game changers in a positive sense: They can revolutionize scientific discoveries and space travel. Such is the intent of the Breakthrough Starshot program, which aims to build a ground-based, 100-gigawatt, directed energy laser array to propel the first space mission to another star system, Alpha Centauri. Directed energy propulsion can move space travel beyond the boundaries of current rocket technology and balance the perception of how it has been portrayed by science fiction.

Directed energy propulsion will allow space travel beyond that which has dominated to date: basically in and out of Earth's celestial "driveway," which includes low Earth orbit (no more than 2,000 kilometers above Earth's surface) and geostationary orbit (roughly 36,000 kilometers away, a distance slightly less than the circumference of Earth). Directed energy propulsion can revolutionize interplanetary spaceflight by significantly shortening the travel time to distant planets, thus potentially enabling interstellar flight within decades.

Beyond propulsion applications, directed energy has the potential to provide Earth a defense against the kind of asteroid that wiped out the dinosaurs (Lubin 2014) and to alleviate what military officials consider an urgent danger: space junk orbiting Earth (Macias 2019). But use of directed energy will require considerable international cooperation to abate the concerns of those who see only directed energy's potential as a weapon, and that cooperation needs to begin now.

Directed energy propulsion as an exponential technology

With the advent of concerted spaceflight development after World War II, experts assumed that space technology would develop exponentially, taking spacecraft –

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