# GET OFF THE ROCK DA

### A. Uniqueness

#### [Howell] Exoplanet research is growing now, and private entities are playing a huge role in these efforts.

Howell: Howell, Steve,B. [Professor at NASA Ames Research Center, National Aeronautics and Space Administration] “The Grand Challenges of Exoplanets.” *Frontiers in Astronomy and Space Sciences*, April 8, 2020. TB

The start of the **Exoplanet section of Frontiers in Astronomy and Space Sciences comes at an opportune time in the history** of this fledgling field. Starting about 25 years ago, with the discovery of small planets orbiting a pulsar (Wolszczan and Frail, 1992) and soon thereafter the seminal discovery of 51 Peg b (Mayor and Queloz, 1995), exoplanet research today spans many scientific disciplines. **The stature of this research area was recently highlighted via the 2019 Nobel prize being awarded to exoplanet researchers Michel Mayor and Didier Queloz. Exoplanet exploration is truly a world-wide phenomena, a topic of conversation and study in many scholarly areas and at many levels.** Science is an obvious area of interest where **exoplanets have become the poster child for multi-disciplinary collaborative science**, encompassing astronomy, astrobiology, biology, astrophysics, geology, and planetary science to name the major players. But other fields of study, such as philosophy and religion are involved as well. The broad reach and general appeal of exoplanet research stems from a long fascination we have for the night sky. “Are we alone?” that uniquely human question, has deep roots within us all, likely beginning as soon as we looked up at the night sky and wondered. If we examine the history of major scientific areas of research, those that stemmed from grass root beginnings based on an amazing and unexpected discovery or idea and then quickly proceeded to produce many initial results, we find **that such fields of study swiftly gained momentum and became their own research speciality within a few years. From each beginning, scientists migrated to the field, out of curiosity, interest, and desire to make early and major contributions.** The rapid re-purposing or development of **new tools** (e.g., instruments, techniques) **quickly led to many new discoveries.** Today, scientists are often drawn to a field by the available resources or funding, but as scientists we all love something challenging, a new playground in which to flex our brains and put our experience to work. Taking the scientific topics of relativity, quantum mechanics, and dark energy as examples of new breakthrough areas of science that exploded on the scene, we note that typically about 20–25 years after the stirrings began, major discoveries, deep understanding, and paradigm changing results appeared. Thus, **I fully expect that same** **revolution to happen in exoplanet research in the next few years. From the NASA Kepler mission (Borucki et al., 2010; Howell et al., 2014), through TESS (Ricker et al., 2016), and CHEOPS (Cessa, 2019), to the next generation of large, specialized instruments and telescopes planned for the ground and space, the field of exoplanet research is moving forward at a fast pace. We have already seen the significant shift from exoplanet discovery to exoplanet characterization. Exoplanets aims to be a large part of this research endeavor by bringing open access scientific results, covering all aspects of exoplanet and related science to the world.** Below, we outline where we are at present and then discuss a number of grand challenges that face the field. **These are areas rich in discovery potential and likely to** become sub-fields in their own right. So, come along and **explore the grand challenges of exoplanet science.** Discover for yourself the excitement and opportunities available for scientific study within this research area.

### B. Link

#### [Nguyen-Le] Private entities in space make space exploration more efficient and cost effective.

**Nguyen-Le**: Nguyen-Le, Hanh. [Hanh Nguyen-Le is a second-year Master of Public Administration student at the London School of Economics. She is also the Government Affairs Associate at the Space Foundation, a nonprofit advocate organization for space exploration and space-inspired industries, where she focuses on U.S. Congressional relations and national space policy.] "Billionaire private investment is good for the space industry, whether we like it or not.", *The LSE US Centre*, July 19, 2021. EM

**How billionaires support the space industry Private investment in space has created competition and reduced space launch costs. New space actors began to challenge the government-created monopoly, United Launch Alliance (ULA), for contracts, creating competition and introducing a market for small-medium class reusable launch. SpaceX’s Falcon 9’s average cost is $62 million, while ULA’s Atlas V starts at $110 million per launch. Commercial actors enable the government to have multiple competitive proposals to select from during project development. NASA would pay less money upfront for a service, while private companies can operate and have autonomy over their final product. The government can act as a buyer of commercial services, which allows NASA to be more efficient and cost-effective, as the agency can cut costs by only developing projects it has expertise and funding for. Such competition has dramatically changed space technology. New players that enter the space industry are able to embark on ambitious projects at a greater scale and faster pace. Innovative concepts such as reusable rocket stages has shifted the launch industry into integrating reusability into vehicle design and the proliferation of ridesharing missions has decreased the costs of space launch.** This has lowered barriers to enter the space industry, making small satellites rideshare as low as $1 million per mission. Innovations in space launch have further changed the policy environment and streamlined launch and reentry regulations. Billionaires in space are here to stay Investment from wealthy individuals in recent decades have stimulated private markets and paved the way for many startups to enter the industry. As more new players join the commercial space industry, access to space becomes cheaper, resulting in an explosion of proposed satellite constellations and small launch vehicle concepts. Wealthy entrepreneurs have seen an opportunity to take advantage of a lack of government interest in space exploration funding. The high-risk nature of space exploration requires substantial upfront investment that only wealthy individuals can provide before any pay-off. Private investments in space promote competition and innovation. Billionaires providing upfront investments has stimulated the space market and made space more accessible – and profitable.

### C. Internal Link

#### [Goswami] The billionaire space race has long term benefits.

**Goswami**: Goswami, Swish. [Forbes Councils Member] "Why The Billionaire Space Race Is A Good Thing", *Forbes*, September 14, 2021. EM

Odds are you’ve recently seen the news that both Richard Branson and Jeff Bezos have successfully left our planet temporarily in spacecraft their own companies have built. **These two successful trips are just the latest chapter in the “Billionaire Space Race.” The beginnings of this story originate with Peter Diamandis, who helped spur the initiation of the Ansari XPrize. According to the organization’s website, “The $10 million Ansari XPRIZE was designed to lower the risk and cost of going to space by incentivizing the creation of a reliable, reusable, privately financed, crewed spaceship that finally made private space travel commercially viable.”** While the XPrize was initiated in the mid-‘90s, the winner was crowned in 2004, with Richard Branson and his company Virgin Galactic coming in to license the technology. Branson wasn’t the only entrepreneur interested in privatized space travel. Four years prior to the awarding of the Ansari X Prize in 2004, Amazon CEO Jeff Bezos founded his own space exploration company, Blue Origin. Two years later, after the acquisition of PayPal, Elon Musk founded his company SpaceX. Before diving into why I think the Billionaire Space Race is a good thing, I want to take a minute to look back — **all the way back to the 1960s space race. What started with a speech from President Kennedy in 1962 ended with a man on the moon less than seven years later. This space race unified a country, created 400,000 jobs across science, technology and manufacturing and inspired a generation to think ambitiously. The impacts of the original Space Race are still felt today.** NASA’s 2019 article highlights some of the Apollo technologies still in use more than 50 years after the moon landing. Their list includes things like digital flight controls, food safety, space blankets, quake-proofing, rechargeable hearing aids and more!

**[Williams]** Satellites are essential for Earth, and private entities supply them. We need private entities to increase the production of these important satellites.

**Williams:** Williams, Matthew, Space writer HeroX “Is it worth it? The cost and benefits of space exploration” *Interesting Engineering* 2019

**The** most obvious **benefit of** the **Space** Age **was the way it advanced humanity**'s knowledge of space. **By putting satellites and** crewed **spacecraft into orbit, scientists learned a great deal about Earth**'s atmosphere, Earth's ecosystems, **and led to the development of** Global Position Satellite (**GPS)** **navigation**. The deployment of satellites also **led to a revolution in communications technology**. Ever since *Sputnik 1* was launched to orbit in 1957, about **8,100 satellites have been deployed by** forty countries **for** the purposes of **telecommunications, television, radio broadcasting, navigation, and military operations.** As of 2019, the United Nations Office for Outer Space Affairs (UNOOSA) estimated that were [5,074 satellites](http://www.unoosa.org/oosa/osoindex/search-ng.jspx?lf_id=#?c=%7B%22filters%22:%5B%7B%22fieldName%22:%22en%23object.status.inOrbit_s1%22,%22value%22:%22Yes%22%7D%5D,%22sortings%22:%5B%7B%22fieldName%22:%22object.launch.dateOfLaunch_s1%22,%22dir%22:%22desc%22%7D%5D%7D) in orbit of Earth. And **in the coming years, thousands more are expected as part of the growing telecom and satellite internet markets.** In the latter case, these **satellites will be essential to meeting** the growing **demands** for wireless services **in the developing world.** Between [2005 and 2017](http://www.itu.int/en/ITU-D/Statistics/Pages/facts/default.aspx), the number of people worldwide who had internet access went from 1 billion to over 3.5 billion - 16% to 48% of the population. Even more impressive, the number of people in developed nations to have internet access went from 8% to over 41%. **By the latter half of this century, internet access is expected to become universal.**

### D. Impact

[**Maanas Sharma]** Private space exploration and appropriation will lead to more accessible ressources.

Maanas Sharma: Maanas Sharma “The privatized frontier: the ethical implications and role of private companies in space exploration” 2021.

**Another** **key matter to note is** restricted **capitalism in space “could also be our salvation.**”[11] **Private space exploration could** reap **increase**d **access to resources** **and other benefits that can be used to solve** thevery **problems on Earth** that critics of capitalism identify**.** Since governments offset some of their projects to private companies, **government agencies can focus on altruistic projects that otherwise would not fit in the budget before and do not have the immediate commercial use that private companies look for.** Scott Hubbard, an adjunct professor of aeronautics and astronautics at Stanford University, discusses how **“this strategy allows the space agency to continue ‘exploring the fringe where there really is no business case’” but still has important impacts on people down on Earth.**[12]

#### [Gohd] We are RUNNING OUT OF TIME, we will run out of resources on earth in a few hundred years.

Gohd: Gohd, Chelsea. [Writer for Futurism.] “Stephen Hawking: Humans Must Leave Earth Within 600 Years.” *Futurism*, November 7, 2017. TB

Earlier in the year, **Hawking said that: “We are running out of space and the only places to go to are other worlds. It is time to explore other solar systems. Spreading out may be the only thing that saves us from ourselves. I am convinced that humans need to leave Earth.”** A major concern of Hawking, and others, is that **climate change is already causing rapid sea level rise.** It is possible that, **if this progression isn’t diminished by a cut in emissions, a significant percentage of what is currently land will be under water.** (This is, of course, in addition to the other life-threatening effects of climate change.) Additionally, as this continues, **populations are set to continue increasing, which could have disastrous consequences. Hawking is confident that within the next few hundred years, Earth will no longer be a habitable option for humans.** This hypothetical day when humans will supposedly have to leave Earth has been likened to a “Doomsday.” Hawking has asserted multiple timelines for this eventual moment, but he is certain that, at some point, we will have to find a new home. With ongoing projects by NASA, SpaceX, and both private and government agencies around the globe, it is likely that within the next few decades we will land humans on Mars. And, between proposals to terraform Mars and innovative designs like those from the Mars City Design competitions, it is possible that, if humans must leave earth, the red planet could one day be our alternate home. In addition to efforts to reach Mars, Hawking helped to launch the Breakthrough Initiatives, a series of projects seeking to probe “the big questions of life in the Universe,” including finding and communicating with extraterrestrial life. **One of these initiatives is Breakthrough Starshot, which will send nanocraft to Alpha Centauri, our closest star, in an effort to better understand life in the Universe. This technological platform could also allow us to find faster and better ways to travel to other planets.** After all, if Hawking is right, **the International Space Station (ISS) isn’t big enough to house the billions of people who currently reside on planet Earth.**

EXTINCTION OUTWEIGHS THEIR IMPACTS, IF SOMETHING IS PREVENTING EXTINCTION IT IS JUST

#### CASE

#### [Myers 16] Prohibitions on appropriation prevent asteroid mining despite growing space industries

**Myers 16:** Ross Myers (J.D. candidate at the University of Oregon Law School.), The Doctrine of Appropriation and Asteroid Mining: Incentivizing the Private Exploration and Development of Outer Space, 2016, Oregon Review of International Law, https://scholarsbank.uoregon.edu/xmlui/bitstream/handle/1794/19850/Meyers.pdf?sequence=1

Despite a decrease in national space program funding, corporate space missions are on the rise. In 2010, President Obama proposed that NASA exit the business of flying astronauts from Earth to low Earth orbit and move it to private companies.52 Several companies have stepped up to bat, and corporate space programs now include space tourism, supply missions, and in one case a one-way colonization mission to Mars.53 Corporate interest in space tourism and development demonstrates a strong private commercial interest in space as an industry, which could serve to finance the exploration of space in a period where national governments do not have an active financial interest in space. However, under current international treaties, the ownership of asteroids is prohibited, preventing corporations willing to invest in asteroid mining from having a secure claim.

Relegating at least some mining companies to near-Earth asteroids would reduce the negative effects of future mining levels on Earth. The economic benefits of mining need not be sacrificed for the sake of the environment.38

#### [Reich 22] Prohibitions on appropriation prevent asteroid mining despite growing space industries

**Reich 22:** Aaron Reich, 1-6-2022, "Asteroids can destroy the Earth, asteroid mining can help save it," The Jerusalem Post | JPost, https://www.jpost.com/science/article-691731//SJJK

An asteroid impact has the potential to cause worldwide cataclysms and extinction-level events, but they could be mined as an alternative to heavily polluting mining on Earth. [Asteroids](https://www.jpost.com/tags/asteroid) make up one of the most numerous types of objects in the solar system. Currently, 1,113,527 asteroids are known to exist in the solar system, according to NASA, but those are just the ones definitively identified, with experts always finding more. These large space rocks vary in size, some less than a meter wide, others stretching several kilometers. Some of these just orbit around the sun, never approaching anything else. Others skirt dangerously close to planets, including several close brushes with our own planet – and on a few occasions, actually hitting us, causing an impact event. These impacts are incredibly destructive and have the potential to be the cause of major catastrophes, destroying cities, continents or even a global disaster. The destructive nature of asteroids, even small ones, is something well known to experts, with space agencies around the world monitoring for potential catastrophic impacts, as well as researching potential means of identifying them and stopping them. It is something that has also long permeated the realm of popular culture, whether it be from now classic films like Armageddon or the very recent Don’t Look Up. BUT ASTEROIDS are not necessarily just the harbingers of destruction we have long considered them. Rather, they may just be able to help save the Earth. Asteroids are, essentially, rocky remnants of the formation of the solar system. Sometimes called minor planets, these rocks are made of various materials and minerals from those early days. Billions of years ago, many of these asteroids are thought to have collided together to eventually form planets, and the minerals and materials support this. So what kinds of minerals could we find on asteroids? According to the Weizmann Institute of Science’s Dr. David Polishook, who is also a member of [NASA’s Double Asteroid Redirection Test (DART) Mission](https://www.jpost.com/science/nasas-iron-dome-dart-takes-off-to-test-asteroid-deflection-686826) which seeks to test asteroid deflection in order to avert an impact, there are three categories we need to care about. First, he told the Magazine, there are strong metals, such as iron and nickel. These are relatively common on Earth and can be used in a variety of applications. Second, there are the rarer metals such as platinum and iridium. These minerals are very rare and extremely expensive. As such, there is definitely a profit to be made by bringing these to Earth. The third isn’t a mineral exactly but is still something extremely important: water. “Yes, the same H2O we all drink,” Polishook clarified. This itself isn’t unsurprising. Scientists have long known water and ice to be present on various asteroids throughout the solar system. In fact, it is commonly theorized that asteroid impacts are what ended up bringing water to Earth in the first place. The scientific community is well aware of the potential value of this field, as while the collective mass of asteroids may not seem like much compared to a planet – indeed, according to NASA, the combined mass of all asteroids in the asteroid belt between Mars and Jupiter is actually less than the Earth’s Moon – they are still filled with valuable materials in extremely high quantities. Indeed, there is even a large resurgence in asteroid exploration in recent years. Several recent missions have already been launched to bring back samples of asteroids. These include the Hayabusa and Hayabusa2 missions from the Japan Aerospace Exploration Agency (JAXA) and NASA’s ongoing Origins, Spectral Interpretation, Resource Identification, Security-Regolith Explorer (OSIRIS-REx) mission. Hayabusa managed to bring back a sample from 25143 Itokawa, Hayabusa2 brought back a sample from [162173 Ryugu](https://www.jpost.com/science/article-689341) and OSIRIS-REx is currently bringing back a sample from [101955 Bennu](https://www.jpost.com/health-science/will-500-meter-asteroid-bennu-hit-earth-in-next-century-nasa-investigates-676537). Interest hasn’t waned either. In October, NASA launched its latest probe, known as [Lucy](https://www.jpost.com/science/nasa-to-launch-first-space-probe-to-study-jupiters-trojan-asteroids-682158), to study Trojan asteroids near Jupiter in a first-of-its-kind mission. Later, NASA plans to send a probe to [16 Psyche](https://www.jpost.com/health-science/what-is-a-10000-quadrillion-asteroid-the-size-of-cyprus-really-made-of-676243), a massive asteroid 227 kilometers in diameter – longer than the maximum length of Cyprus – rich in iron and nickel that was once believed to be worth around $10 quintillion, which is more valuable than the entire global economy, though this exact value is still up for debate. Even the United Arab Emirates, coming off the success of its recent Mars mission, is planning to [land a spacecraft on an asteroid](https://www.jpost.com/science/uae-to-launch-mission-to-explore-venus-land-on-asteroid-681622). Ostensibly, these missions are less about mining and more about scientific curiosity, as asteroids hold keys to understanding the formation of the solar system and, by extension, our very planet. However, that is not to say asteroid mining has not generated interest elsewhere. In fact, there are already laws on the books about it. Asteroid mining is specifically mentioned in the United Nations-mediated Outer Space Treaty, signed by over 100 countries worldwide, and some countries like Luxembourg have already legislated local laws about it. Economically, there are other benefits to this as well. “Mining materials rare on Earth could make the miner rich,” Polishook explained, comparing it to the boom of the 19th-century California gold rush. Yes, launching mining missions to asteroids is expensive, but the returns could be worth it. Especially since asteroids have materials there that astronauts could use. This includes water, which can be used for drinking, creating oxygen for astronauts to breathe, or creating hydrogen for spacecraft to use as fuel. It could also be possible to mine a certain type of helium isotope known as helium 3. A thin layer of this light material that originates from the Sun can be found on the surface of any atmosphere-less body, including asteroids, and it could be possible to turn this into energy through nuclear fission. In other words, economically, the cost of these missions could be negligible. There is also great interest in identifying asteroids that would be prime targets for these missions, with many prioritizing large and close-by asteroids. One website, the asteroid value database [Asterank](https://www.asterank.com/), has even begun estimating the value of various asteroids as well as the estimated profit of these missions. Right now, according to Asterank, a number of asteroids are valued over $100 trillion, but in terms of cost-effectiveness, the most profitable is Ryugu, with an estimated value of $82.76 billion and an estimated profit of $30.08b. Another ideal target, though much more difficult, is Ceres, the largest asteroid in the asteroid belt, with a diameter of around 980 kilometers – in fact, it is so large that, according to some scientists, it should actually be considered a planet in its own right – which is rich in ice water. This could serve as an ideal hub of sorts for these mining missions. HOWEVER, THERE are obstacles in the way of asteroid mining succeeding. According to Polishook, there are three major obstacles in the way. “First, identifying the composition of an asteroid using a telescope and determining if it is rich with water, iron or platinum is still not straightforward. This is especially true for platinum, which was only recognized in meteorites that reached the Earth. It is only reasonable you can find these in asteroids, since meteors come from asteroids, but platinum was never seen in them before. “A close look at an asteroid using a spacecraft can identify these materials, but one can’t send thousands of probes to thousands of asteroids to look for platinum while keeping their budget balanced,” he explained. “Second, reaching the relevant asteroid is also a challenge, though it has been done before. To do this commercially, you will have to invest much more in R&D for your vehicles and equipment. “Third, digging in an asteroid or dismantling it or vaporizing it and carefully collecting the ore you need, whether platinum or even water, is not an easy task when you need to work in zero-gravity,” he added. “While it is a lot of material to sift, these bodies are not large enough to have a strong gravity of their own. Thus, you cannot land on them or stand on them and mine. The miners, whether humans or robots, will have to hook themselves in some way to the surface in order to work while the asteroid rotates at a few hours per circle.” And it isn’t as though NASA hasn’t tried to do this before. “Some years ago, NASA developed a tool to capture an asteroid, but with these many hard-to-solve technological issues, this tool became relevant to only lift a 2-meter-wide rock from an asteroid surface, and eventually this program was canceled. So, objectively, this issue is hard to solve,” Polishook said. Even the promise of helium 3 isn’t enough, because while it is theoretically possible to turn it into energy through nuclear fission, scientists currently have no way or even an idea of how to actually do this, putting it firmly in the realm of science fiction at the moment. Despite their further planned asteroid missions, Polishook doesn’t think NASA or other national space agencies will get into mining operations in the near future – they have enough on their plate as it is, he said. Most likely, asteroid mining would fall into the realm of the private sector. However, people have already tried and have paid the price.