A New Gaze into the Cosmos: The James Webb Space Telescope Takes Flight!

- by Yuan-Sen Ting, Dec 2020

2020 has been an arduous year, but as we approach its final phase, let's discuss the excitement brewing in the astronomical community for 2021.

Academics as American Idol

In recent years, there's been talk about the "hustle culture" where people are grinding away, often with extended hours well beyond the traditional 9 to 5. I recently caught up with an old college friend over dinner, who joked that during the crunch times in academia, it felt like they were on a "24/7" schedule. It's crucial to remember that working in academia often requires bursts of creativity and inspiration. So, finding that work-life balance is essential. We shouldn't glorify relentless work schedules like "24/7". It's like with athletes: simply practicing without purpose isn't productive. But, when deadlines approach in November, things do tend to ramp up.

The primary task? Drafting project proposals.

To shed light on what professors do beyond teaching: In nations like the U.S. (and similarly elsewhere), the government allocates funds to bodies like the National Science Foundation (NSF) and NASA. Universities might provide professorial salaries, but this doesn't cover research team expenses. Thus, academics must vie for research funds from NSF and NASA. These institutions involve external researchers for double-blind reviews of proposals, ensuring impartiality. Yet, over the last few decades, global science investment has been lackluster. Despite drafting detailed, lengthy proposals, only about 15-20% receive funding – a sharp decline from the 40-50% in the 1990s.

While a 15-20% success rate might sound promising, remember that those applying are the crème de la crème in their fields. It's akin to competing on "American Idol." Having served as a reviewer, I can offer insights: often, science's benefit to mankind is clear. But with limited funds, reviewers might resort to nitpicking, offering feedback like, "The singer has talent, but didn't resonate with me," or "They hit a wrong note."

Beyond research fund applications, astronomers frequently request telescope time. Given the limited number of top-tier telescopes and only 365 observational days a year, the

competition is fierce. This autumn heralded exhilarating news: the highly anticipated James Webb Space Telescope is slated for a late 2021 launch. Its first proposal round took place this November, hence many spent the month drafting their submissions.

The James Webb Space Telescope's main goal is to succeed the Hubble Space Telescope, in operation for three decades. Essentially, after a thirty-year wait, astronomers are transitioning to a new home. Yet, not everyone will gain immediate access. Securing time on Hubble was even more challenging than getting research funds, with a mere 10-15% success rate. For the James Webb, projections hover around a 5-7% success rate. This 5% rate mirrors "The Hunger Games."

The James Webb Space Telescope

Why is everyone clamoring for observation time on the James Webb Space Telescope?

In short, the James Webb will be the largest space telescope ever built, boasting a 6.5-meter aperture. This is six times the size of the current Hubble Space Telescope. To grasp the magnitude of this feat: the telescope is so large that no rocket can accommodate it in its entirety. It has to be folded up, akin to Japanese origami, before being deployed mechanically in space. Let's break down a few concepts here.

1. Why Build Larger Telescopes?

This can be simply understood with an analogy: imagine the universe's light as drizzles of rain. The larger the bucket you have, the more rain you can collect in the same amount of time. James Webb is akin to a bucket that's six times larger, allowing it to collect light six times faster than the Hubble. What used to take a decade to observe can now be done in less than two years. A larger telescope can also observe fainter objects, which equivalently means observing more distant objects.

2. Why Launch Telescopes into Space?

Some might wonder, wouldn't it be easier to build large telescopes on Earth? While ground-based telescopes play a crucial role and can indeed be much larger (with the largest optical telescopes nearing 30 meters in diameter, roughly half a soccer field), space telescopes

offer two main advantages, both related to Earth's pesky atmosphere. Firstly, our atmosphere distorts light, causing stars to "twinkle" and undermining precision required for some astronomical observations. This is why, for very precise observations like those where you'd need to detect a hair's movement from across the South China Sea, you'd have to venture into space. Secondly, while our atmosphere protects us from harmful radiation like UV and X-rays, it also filters out useful information, limiting ground-based telescopes to only observing light that can penetrate the atmosphere.

What breakthroughs can the James Webb Space Telescope bring to astronomy? This can be expanded upon from the two points above:

Observing Distant Phenomena:

The universe itself acts like a time machine. How so? Light travels at a finite speed (approximately 300,000 kilometers per second). For instance, sunlight takes about eight minutes to reach Earth. This means when we see the sun, we're actually seeing it as it was eight minutes ago. Given the vastness of the universe, a major aspect of astrophysics involves observing very distant galaxies. Their light has traveled across the universe for billions of years before reaching us. It's like sending a letter to yourself that you'll only read 20 years later. Reading that letter two decades later lets you understand what things were like 20 years ago. This is why we can gain insights into the early universe. Since the universe is so vast, the further we can see, the older the "letters" we receive. The James Webb Telescope allows us to look further than the Hubble, collecting "letters" from the early universe and offering us glimpses into its history.

Observing Different Light Wavelengths:

Another hot topic in astronomy is the search for extraterrestrial civilizations beyond our solar system. Astronomers don't literally "search" for aliens, as they're too distant. Instead, they look for planets with atmospheres similar to Earth's. An effective way for extraterrestrials to detect Earth would be to see if sunlight, when passing through Earth's atmosphere, has certain parts absorbed. Understanding this absorbed light can inform about Earth's atmospheric composition, indicating possible signs of life. The James Webb's focus includes looking for signs of water vapor and other organic gases in the light from stars when it passes through their planets' atmospheres.

Pausing the Pen, But Not the Passion

The launch of the James Webb Space Telescope next year is a monumental event in the scientific community. However, the continued use of the aging Hubble over these three decades highlights an issue. Many question the funding of basic science. Yet, research funding is a drop in the bucket compared to other governmental expenditures. Just a fraction of the finances from a multinational corporation, if allocated to research, could lead to quantum leaps in scientific advancements.

Think about it: if our vaccine technology was ten times more advanced than it is now, our current predicaments might be non-existent. Despite these challenges, science often becomes the primary target for budget cuts, leading to a vicious cycle.

This cycle results in researchers struggling for resources, often for amounts that might seem trivial in other sectors. This desperate fight for survival means they rarely have the energy left to communicate their work to the public. This lack of communication dims public interest in science, allowing opportunists to mislead and misinform. Consequently, the government feels more justified in slashing science budgets, worsening the predicaments many researchers face. One of the reasons for writing these articles is the hope to make a small change in this narrative.

When I first started writing, I pondered: as an scientist with average writing skills, and not as eloquent in explaining science as some popular science YouTubers (I personally enjoy Veritasium, highly recommend it!), what could I offer? What I can share are the joys and struggles of a researcher. While I'll be taking a break from writing due to the demands of funding applications, research, and mentoring students, I hope to share more with all of you in the future.
