**Rainbows (November 2029)**

Mitch Harvey swung off the Oak Drive exit of Freeway 210 and drove to the parking lot at the rear of JPL. He parked his old and battered 2015 Kia Rio at the back of the lot, eying with envy the latest Teslas in the named slots by the lab entrance.

He tapped his forefinger on the entry pad and the door slid back with a hiss, his sweat having been recognized by the DNA access library. He was in the fifth week of his internship and couldn’t quite believe that he was allowed in.

He had gone through a series of interviews before being accepted. In the final interview, he was asked “Did anything in particular spark your interest in astronomy?”

“Well, after Mom died, I spent a lot of time with Grandmom, who used to teach at UCLA. She asked me what I wanted to do when I got older. I told her that my real interest was astronomy, but it didn’t seem a very exciting career. After a pause, her response was to ask me if I had ever heard of Carl Sagan?

To cut a long story short, she told me to find on Our Tube a recording of his Christmas Lectures at the Royal Institution in 1977. That’s what – 52 years ago! It was about the first probes to explore the solar system and also the probability of life elsewhere in the Universe.

There was a really funny bit about the camera on the first Mars lander – Viking 1. I mean talk about antiquated. It used a nodding mirror to scan a vertical strip and took 30 minutes for a 300˚ panorama. Sagan asked if it would detect life on Mars.

To make the point, they put the camera on the Main Street in Mars, Pennsylvania with the High School Marching Band streaming past. The data rate was so slow that the image only captured an empty street and the shop fronts opposite! Anyway, after that, I was hooked on the search for extra-terrestrial life.”

The panel all laughed and ten days later, he had a letter offering him a four month placement with Dr Maddy Lopez, to work on something called Project Arcus.

Maddy was an attractive brunette, frighteningly clever and twice his age. When he’d started, she’d given him a quick run-down on what they were doing.

“OK Mitch, time for a bit of history. We are looking for habitable planets outside the solar system – exoplanets. The first was discovered in 1992. Since then we have been searching for them from earth using facilities such as HARPS in Chile and from space using telescopes such as Kepler. Kepler was launched in 2009 and detects planets by measuring the reduction in brightness of the parent star as the planet transits across its face. Within 10 years of Kepler’s launch, we had confirmed more than 3,000[[1]](#footnote-1) exoplanets. In fact, wherever we have looked, we think that there is at least one planet for every star.

The big question as this realization sunk in was ‘how many of these could support life’? Astronomers and astrobiologists nominated various criteria based on a multitude of factors such as presence of liquid water or ice; surface temperature; gravitational field; presence of building block elements – Carbon, Hydrogen, Nitrogen, Oxygen, Sulphur, essential minerals, nutrients, metals; energy sources; surface pressure; radiation levels; climate generally and its extremes, and so on.

The follow-on question is how can we gather this information at inter-stellar distances? Project Arcus is part of the answer. Arcus is a remote sensor capable of operating in both optical and microwave spectra. It goes back to a NASA Research project from the mid-10s called Orbiting Rainbow.

As background, there’s just a bit more science. The resolution of a sensor depends on how large its aperture is compared with the wavelength it’s capturing. Generally, big is better; very big is better still. The real problem is that very big is very difficult on earth and pretty much impossible in space.

Orbiting Rainbow took a different approach. What if you could marshal a cloud of small reflective particles, in space, so that they could be used as a giant telescope mirror, or microwave receiver, or radar dish?

I can read your thoughts. How on earth … or more to the point, in space, do you do that? The answer is to use small glass beads and shape them using the light pressure from laser illumination and some controlling software to ensure that they stay in station with each other. We also call this Granular Imaging.

Orbiting Rainbows proved the principle and we eventually got the money for the Arcus project in 2026 and launched last year. We’ve just completed commissioning and are starting to collect data.”

“Arcus?”

“Oh, Arcus is Latin for rainbow. The particles are like raindrops reflecting sunlight”

“What do you need me to do?”

Maddy explained that each target was listed in a library and they had a standard set of data (or protocol) that would be gathered for every exoplanet. He had to open up the planned run sequence and send a command to initiate the next block of data collection. The system would report back on progress and he was to contact Maddy immediately if any alerts came up on the control screen.

“In the meantime, we have to see if we have found anything significant in the data we already have. Of course, we are generating a vast amount in every sequence, which is next-to-impossible to scrutinise mandraulically. We use a data-mining tool to look for specific features in the data. If any are found, a buffered data set is dropped in a file with some metadata to indicate why it may be of interest. Then we set to work on that.”

“Your job, Mitch, is to initiate the data collection programme for your shift, monitor any alerts on that and, if all looks normal, to have a look at output from the DM.”

“DM?”

“Oh, sorry, data-miner. There are far too many abbreviations around here.”

Mitch helped himself to his customary start-of-shift black coffee, logged in to the control system, pulled down the collection plan and sent the appropriate commands to the Arcus array. He checked the operational status report and the collection command confirmation message.

Seeing that all was well (or ‘nominal’ as they called it at JPL), he opened the DM to see if anything new was flagged.

There was a new file identified as Kepler-186 f with a sub-folder entitled 10-26-2029 1303UTC optical spectrum structured data.

He had no idea what this meant, other than the fact that it referred to data whose collection he had initiated the previous week. He opened the file and saw the expected raft of tabular data, in this case of brightness versus wavelength. He right-clicked on the Processing Tools Menu and asked for a graphical display of the data.

When he saw the display, he nearly dropped his coffee mug. He reached for speed-dial and called Maddy. “Maddy, come down to control and have a look at some data on Kepler-163 f that I just downloaded from the DM!”

As she burst through the lab door, he swivelled round, pointed at his screen and said “Come and look at this! I’ve got something, but I’ve no idea what!”

She glanced at the screen and said, with an excited grin “Looks like you’ve got a rainbow!” Deftly scrolling through the data and confirming wavelengths she said “Remember this day, because nothing like it may ever happen again in your career”.

“This structured data means that there is something reflecting bands of light at different wavelengths from the planet’s upper atmosphere. The best bet is water vapour in clouds or water ice crystals. I’ll pick up analysis of this after we’ve sorted out the immediate actions. Which are …” she paused in thought “… first we call the Project Director, then we need his permission to send a telegram to the IAU Central Bureau for Astronomical Discoveries and then to release this dataset to our partners in ESO, Chile and Australia to get an independent review. Then we set a Press Conference at NASA HQ for next week.”

“Presumably this is evidence that Kepler-163 f might support life of some kind?”

“Certainly it increases the chances. It’s probably going to make the network news. How’s your television profile?”

“Non-existent. Yours?”

“OK, one more thing. Before the news conference we need to agree a name for this planet. It was originally discovered by the Kepler telescope, but we can replace the ‘f’ with something more meaningful, provided the IAU, NASA and JPL agree. Don’t get too excited; we can’t use the names of living persons, so Mitch Harvey and Maddy Lopez are not going to feature.”

“What about Arcus Sagan 1?”

“Great idea! Arcus is correct because it’s a Project Arcus discovery and Sagan is perfect.”

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Ten days later after a welter of activity, Mitch, Maddy and the Director were sat behind a bank of microphones and in front of several TV cameras in the NASA Presentation Theater. After a short briefing and the barrage of flashes from the press cameras, the correspondents asked their questions.

“Mitch”, called one “Jim Roberts, BBC Science correspondent, what do you think is at the end of the rainbow on Arcus Sagan 1?”

“Well, who knows? Perhaps, if Carl Sagan were here, he would say with that familiar grin ‘I hope it’s life, Jim, but not as we know it!’”

The room collapsed with laughter and Mitch raised his hand and said “I apologise, but I couldn’t resist that.”

The headline worldwide on the evening news and in the next day’s papers was “There’s Life at the end of the Rainbow – but not as we know it!”

Ron Smith

08/05/16

Ref 1: <http://optics.org/news/6/10/9>

1. 2,111 by 2nd May 2016 [↑](#footnote-ref-1)