ASTR1001 “Astrophysics” Assignment 1.

The Assignment.

It is the year 2076. You are all science officers on the starship USS Drongo. Your mission – to investigate the source of some mysterious radio signals coming from a distant part of the galaxy.

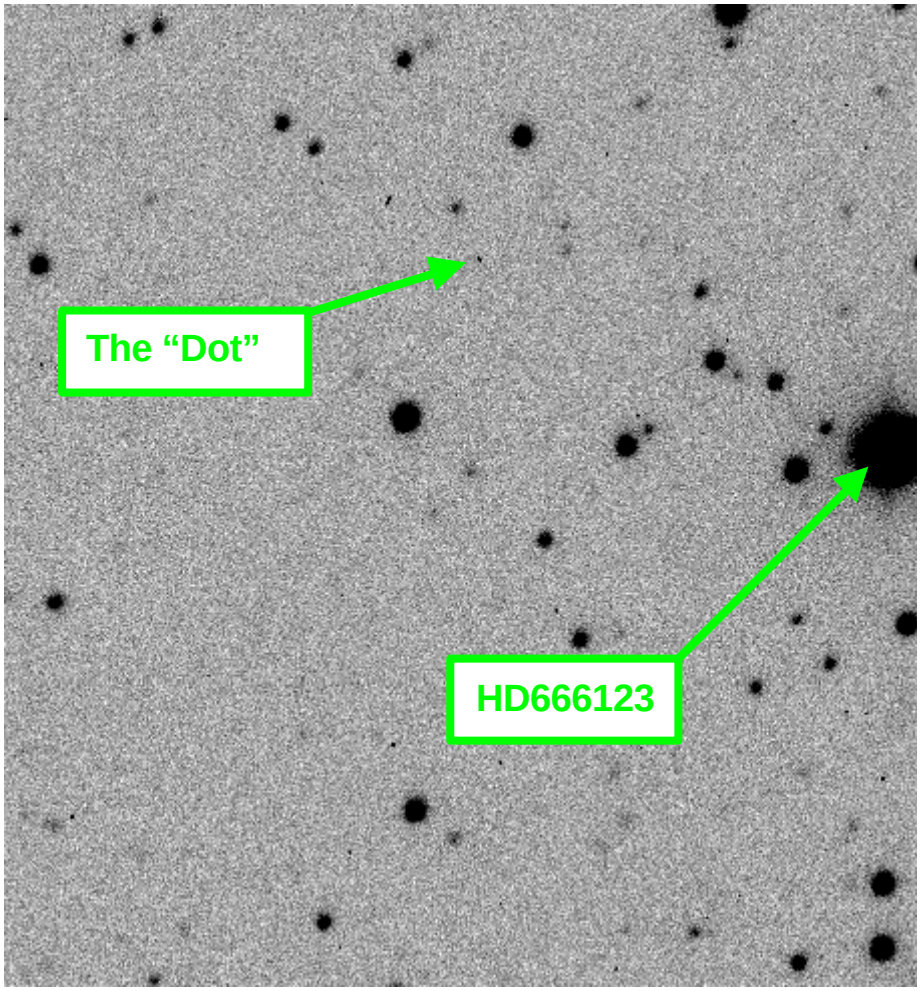
Five years ago, the giant radio telescopes in outback West Australia detected radio signals, apparently coming from a planet orbiting the obscure star HD666123, in the constellation Carina. The signals seem to be artificial. All efforts to decode them have failed, but it is generally believed that they must be coming from some advanced technological alien civilisation. This is the first sign of intelligent life in space.

The President of Australia, acting in her capacity as Secretary General of the United Nations, decided to send the world’s most advanced starship, the USS Drongo, to investigate. You all volunteered to be members of the science team on board.

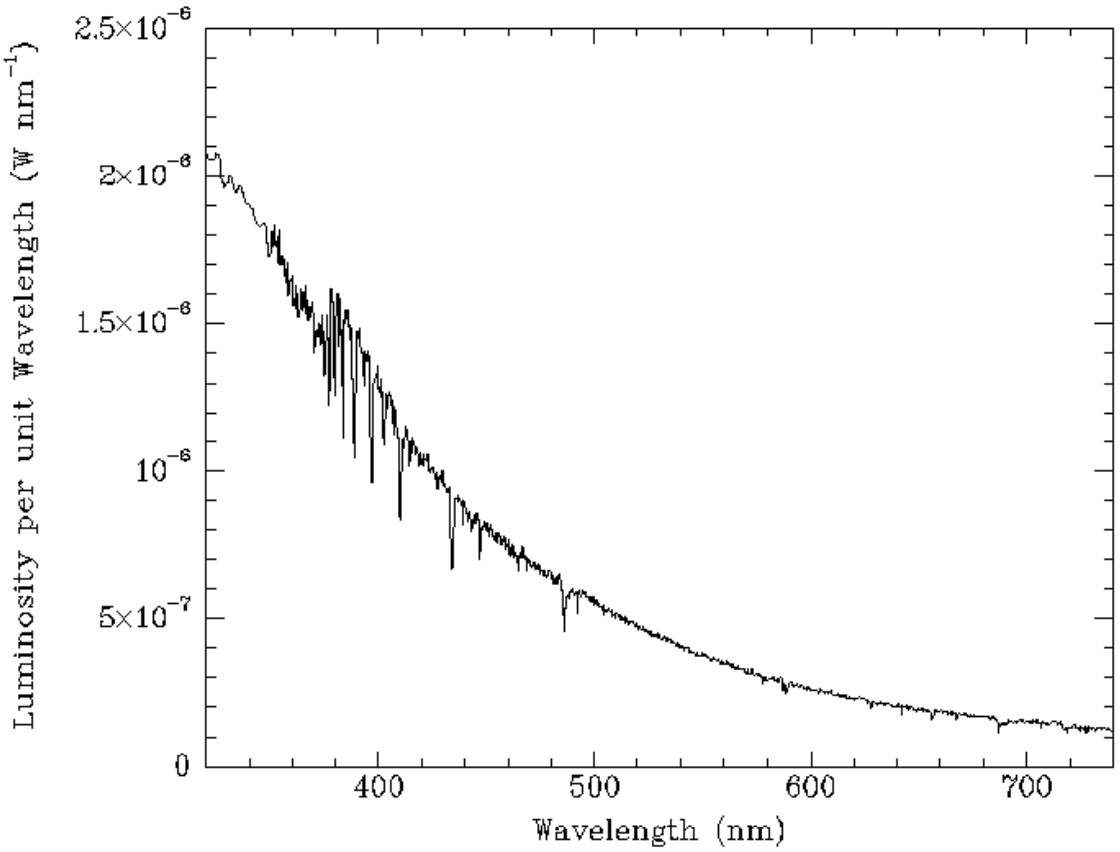
The ship set off four years ago, but even with its advanced faster-than-light warp drive (based on principles discovered by an ANU honours student in 2004), it has only just arrived in the vicinity of HD666123 (which the crew affectionately refer to as “Twinky”). The on-board robots have just defrosted you all from suspended animation, and you are keen to get to work.

Captain Chubb is a cautious woman. Contact with aliens could be disastrous both for you and for the whole human race, if it goes wrong. She is therefore keeping the USS Drongo about half a light-year away from Twinky, hiding out in its comet belt. From this (hopefully) safe hiding place, she has ordered the science team to deploy your telescopes, and learn as much about this system and its inhabitants as you can. Once you have discovered everything to be learned from this distance, she will decide whether to approach closer.

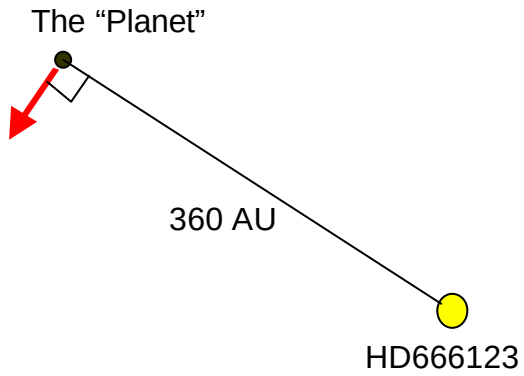
The Data So Far.



The radio signals are coming from the dot of light marked in the above (negative) telescope image, which was taken at a wavelength of 500nm. You are too far away to make out any details with your best telescope.



You obtained a spectrum of the star HD666123 (Twinky), measured at optical wavelengths. It appears to be a fairly standard blue giant star, of spectral type B0. Such stars are typically 5.85 million kilometres in radius, and have surface temperatures of 30,000K. They are typically 17.5 times more massive than our Sun, but their typical luminosity is 52,000 times greater than that of our Sun.



You’ve been tracking the dot, from which the radio waves are coming, for four days now. and it appears to be moving. This suggests that it is a planet, either moving in some sort of orbit around HD666123 or just flying past it. At present it lies 360 AU (astronomical units – the distance between the Earth and our Sun being 1 AU) from Twinky, so it is a long way out (Pluto is only 40 AU from our Sun). It is moving quite slowly – at 5.4 km/s (about a quarter the speed of the Earth as it goes around our Sun). It is moving at right

angles to Twinky (see the picture above). Both Twinky and the "planet" are the same distance from your current hide-away. The radio signal shows no Doppler shift, so the "planet" cannot be moving towards or away from you.

With your photometer, you measured the precise brightness of HD666123 and of the "dot" at three different wavelengths, using three filters to isolate the relevant wavelengths:

Filter	Wavelength (nm)	Luminosity of HD666123 ($W\ nm^{-1}$)	Luminosity of the "dot" ($W\ nm^{-1}$)
B	500	3.20×10^{27}	3.12×10^{13}
K	2,100	1.53×10^{25}	3.01×10^{13}
L	10,000	3.27×10^{22}	3.00×10^{14}

That's all you've been able to measure so far (it's hard from this far out). Your job is now to deduce as much as you can from these few facts.

The Assignment.

This is the first of three assignments based on the "mystery planet"

For this first assignment, you should deduce as much as possible about the "dot", using the data that I've provided here. Over the next few weeks I'll release more data, and that will be the subject matter for the next two assignments.

You can work as individuals or as a team. This course is not marked on a relative scale, so if you help someone else, it will not hurt your mark. I am quite happy to give the whole class High Distinctions, if you all deserve it.

To help you communicate outside of class, you can use the course bulletin board or the course e-mail (accessed through WebCT). If you are stuck, post a question to the bulletin board, and someone may help you. If you've figured out something brilliant, post that to the bulletin board and it will help others.

The Library.

To help you with this assignment, you can consult the USS Drongo's library of astrophysics, via WebCT. This contains some special reference books of relevance to this project.

Marks.

This assignment is worth 5% of the marks for ASTR1001.
If you wish, you may work in teams. If you do so, you need only submit one write-up for the whole team, and you will all be given the same mark. Team submissions will be marked in exactly the same way as individual submissions.

Deadline: Monday 25th March, 9am. Assignments should be submitted electronically via WebCT. A special link will be provided.

Your write-up should be at most 300 words long, summarising what you have deduced about the mystery planet. It should be written in the style of an 'Executive Briefing' for Captain Chubb. You should concentrate on facts that might be important to this mission, and on the physical reasoning that led you to these conclusions.

Assignments or progress reports handed in late (unless you get my prior permission) will not be marked (I know this is nasty and tough, but this is also how things work in the real world).