"The Sparrow" (Mary Doria Russell)

I read this book when it was first published (1996?) due to the rave reviews, well in New Scientist anyway. It annoyed me immensely. It did not quite join the select ranks of books-I-have-thrown-against-the-wall, but it came close. Nevertheless I decided to read it again. I now realise I probably didn't get it the first time around. Either that or I have mellowed with age (who, me?). In either case, I recant my former heresy. What residual irritation persists I will elucidate shortly.

Science fiction it is not. The alien planet merely functions as a suitable setting for an extreme anthropological culture-shock (noting that Russell is an anthropologist). Neither science nor technology are central to the novel, ergo it is not Sci-Fi. The nearest novels to it in nature that I can think of are C.S.Lewis's Out Of The Silent Planet / Perelandra trilogy. These too use an alien planet as a convenient stage for novels which are essentially religious. That's what I didn't get the first time around. It's essentially about religion. I originally thought the whole Jesuit thing was just local colour and inessential. But it isn't. The core of the book is the head on collision between Sandoz's accelerating faith and the awful reality of his treatment at the hands of the Jana'ata. It is, in fact, another replaying of the Problem of Job (how can one retain faith in a world full of evil?) - to which there is no answer.

(Incidentally I note that Russell herself has changed from Catholicism to Judaism via atheism since the book was published. I'm always suspicious of people who can't make up their minds).

The book is well written. It has a goodly sprinkling of those *bon mot* which amuse me. I liked "publish or parish" as a description of Sandoz's difficulty in deciding between academia and the church. Most importantly the book succeeds admirably in fulfilling the one and only functional requirement of a novel: that it compels the reader to keep reading. This is achieved in traditional fashion by setting up the central mystery from the start - what *did* happen on Rakhat? - and not enlightening the reader until the last couple of dozen pages. The build is tantalisingly slow, taking 200 pages to leave Earth, another 100 or so before anything much is said about Rakhat, and yet another 100 before the dreaded Jana'ata enter the story.

Sandoz, our priestly hero, believes their mission is under the personal protection of God. He believes this right up to the moment that he is raped. He feels a mite let down by this and generally a little pissed-off with The Lord. Why did Jehovah refuse Cain's sacrifice, he asks? Sandoz has stuck by the rules, kept celibate, etc, and the Big Man just hasn't played fair. This is the central theme of the novel. I didn't get it first time around because it didn't cross my mind that anyone could be so daft.

I thought the romantic elements rather unconvincing. Men on a mission don't do courting (heck, that would be multi-tasking). And Sandoz's behaviour when back on Earth did not ring true to me either. The conceit and dynamic of the novel is the apparently transcendental horror of what happened to Sandoz. But I'm not sure the dénouement manages to carry the weight of expectation. I think my reaction to this was coloured by the knowledge that Russell herself comes from a culture, the USA, in which 200,000 men are raped yearly - in prisons (double the number of women raped incidentally). But I don't see anyone being too bothered about that.

And now for the physics. There are a few howlers. I realise it's churlish of me to mention them because they do not detract from the literary merit of the novel - but I'm going to anyway (it's probably asperger's). Take for example "*Sandoz was estimated by the physicists to be about 45*". They really wouldn't have needed any physics calculations. They'd have had accurate timepieces with them on the journey. Their watches would remain in perfect sync with their biology. And then there was "*DW turned off the afterburner and she was thrown forward against the belts so hard she thought she'd ruptured her heart*". Oh dear. Easing off the accelerator isn't the same as jumping on the brake! On the positive side, *alpha centauri* really is a triple star system, as claimed. I liked the references to the red-light periods because one of the stars (*alpha proxima*) is a red dwarf, so this would be accurate. And a planet of at least Earth size was discovered around *alpha centauri* B a year ago. Almost a stunning prediction, but it's not Rakhat. The planet's surface temperature is 1200^{o}C. But I note that *alpha centauri* B is the serious planet hunters favourite for harbouring an Earth-like planet according to this week's New Scientist. I won't quibble about the startling coincidence that Rakhat's gravity, temperature, atmospheric pressure and atmospheric composition are all compatible with humans, nor with the humans' ability to digest their vegetation. That's fair game precisely because this book is *not* Sci-Fi.

However, relativistic time dilation plays an important part in the story, in respect of the relative ageing of the earth-bound compared with Sandoz. I confess I initially thought that the claimed journey time of 17 years, reducing to only 6 months from the passengers' perspective, seemed quite reasonable. But I checked it anyway (sorry, I just can't help it). Oh dear. It really is quite seriously wrong. The actual figures are six years Earth time and three and a half years passenger time. It does not detract from the literary merits of the book, but it's disappointing that it's wrong. (I know you'll be all agog to see the calculations, so I have attached them separately).

Score? 7/10 in recognition of original elements, which is increasingly hard to achieve.

Physics of "The Sparrow"

One-way trip duration, Earth time

Distance = 4.37 lyrs = 4.13 x 10^{16} metres. (c = 3 x 10^8 m/s)

Accelerate at 1 g for half that distance, $x = 2.06$ x 10^{16} metres. (1g = 9.81 m/s)

Hyperbolic motion gives $t = \frac{1}{c}\sqrt{x^2 + 2\frac{xc^2}{g}} = 9.47 \times 10^7$ seconds = 3.0 years

Decelerate at 1 g for second half of distance takes another 3 years.

Total elapsed Earth time for outward journey = **<u>6.0 years</u>** (book claims 17 years).

One-way trip duration, voyagers biological time

To half-way point, $\tilde{t} = \frac{c}{g}\sinh^{-1}\frac{gt}{c} = 5.65 \times 10^7$ seconds = 1.8 years

Decelerate at 1 g for second half of distance takes another 1.8 years.

Total passenger biological outward journey time = **<u>3.6 years</u>** (book claims 6 months).

Maximum Speed (with respect to Earth)

$v = \frac{gt}{\sqrt{1 + \left(\frac{gt}{c}\right)^2}} =$ 95% of speed of light, at half-way point

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Peak Time Dilation at half-way point

$\gamma = \frac{1}{\sqrt{1-(v/c)^2}} = \frac{1}{\sqrt{1-0.95^2}} = 3.25$ so that each year on Earth would seem like **112 days** to the passengers (the book claims only 3 days)

Minimum size of asteroid required

Thrust mg equates to exhaust rate-of-mass-loss, $-u\frac{dm}{dt}$, where u is the exhaust velocity. Maximum efficiency is for exhaust at light speed, $u = c$. Integrating gives, for outward journey only, $m_{final} = m_{initial} \exp\left\{-\frac{2gt}{c}\right\}$ where m_{final} must be at least the mass of the people and all the required food, water and equipment, plus the mass of the re-usable parts of the craft, including the engine. $m_{initial}$ is m_{final} plus the mass of the asteroid needed to be used as fuel.

For $2t = 1.89 \times 10^8$ seconds: $\exp\left\{-\frac{2gt}{c}\right\} = 0.002$

Assume m_{final} is at least 500 tonnes (similar to the mass of the international space station), which is rather too light if anything.

Then $m_{initial}$ is at least 500 / 0.002 = 250,000 tonnes. At an average density of 5 tonnes/m^3 the asteroid would only need to be a modest 46 meters in diameter. However, to have enough material for the return journey is dramatically more problematic because of the exponential time dependence. $\exp\left\{-\frac{4gt}{c}\right\} = 4 \times 10^{-6}$, and so the initial mass required becomes 500 / 4 x 10^{-6} = 1.2 x 10^8 tonnes. This is still only a required asteroid diameter of 210 metres. There are plenty of asteroids that size.

Engine Thrust Required

This is where it gets tricky. How are you going to accelerate a mountain of mass 120 million tonnes at 1g for many years continuously? In practice you wouldn't try. You'd rely on picking up another asteroid in the *alpha centauri* system. In that case a modest 250,000 tonne initial mass might be adequate. Not that that makes it simple...

250,000 tonne at 1 g - that'll require a thrust of 250,000 tonne force then! (2,500 MN).

Compare with 1960s technology Saturn V rocket: mass 2,800 tonnes with peak thrust of 34 MN sustained for only two and a half minutes, not the 3.6 years required here. Although old technology, the Saturn V still holds the record for the heaviest payload launched. So, we're going to need an engine about 100 times more powerful, pushing an initial mass roughly 100 times greater, for nearly a million times longer. No problem there then.

The initial exhaust rate would need to be $\frac{mg}{c}$ = 8 kg/second. Accelerating 8 kilos of material to the speed of light every second is some engine. I can't see an 8 kg/s light-speed exhaust engine being developed by the declared launch date in 7 years time. But I'll happily work on it if someone pays me lots of money.

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