EXTRAORDINARY ALIEN

SECOND SECTION

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PARALLEL 1973↑5↓↓31

Zoë's research fellowship at SLAC still had up to a year to run and what with sorting our her visa and Millard busy recruiting a number of other staff members and getting the offices set up with the high performance computers they were going to use to run the system they intended to build on, it wasn't until end of March that Zoë finally left Stanford and started work at the company. Those six months gave her plenty of time to worry about whether she had made the right decision. Her friends and colleagues were pretty much divided down the middle on whether what she was doing was the right thing. Her parents were against, but her aunt and uncle, who were almost like second parents to her, strongly for. Her PhD supervisor thought she was a fool to throw everything she had worked so hard to achieve away for nothing, but her principal investigator from her postdoc at King's in London thought it was too good an opportunity not to seize. Every morning she would wake up with a feeling of vertiginous uncertainty in the pit of her stomach. But having decided once that she *did* want to take Millard's job, despite her constant qualms, she felt that she had to remain committed to the initial path she had chosen. She recalled Andrew, a boyfriend back in PhD days in Cambridge, who had been offered a job and had iffed and affed and eventually had accepted the job and then had changed his mind and stayed at his original company and then had taken the counter-counteroffer and had joined the other company only to leave it after a few months to go back to the first one. His constantly flapping around on the matter,

to Zoë reminiscent of an asphyxiating carp on the lake bank, had not impressed her and she determined that their relationship had run its natural course. No, she would have to stick to her decision. The main other thing that the six months gave her, apart from the opportunity to complete a couple of papers she had started, was the chance to start getting up to speed on the state of the art in artificial intelligence and, in particular, the somewhat heterodox approach Millard intended to take. She read Ashby's *Design for a Brain*, which, along with Good's paper, she began to recast in contemporary terms. In doing so, she thought she caught a glimpse of a possible way forward in creating a design that could be useful as an artificial intelligence. Zoë felt very excited.

They called the system EGO because they had to call it something and it seemed like a good name and was an Arthur C. Clarke reference and therefore a HAL 9000 reference. Exactly what EGO stood for varied from day to day, which amused Zoë: Exponentially Good Optimizer, Evolutionary Growth Observer, Experimental General Operator, Efficient Goal Orientator, Extraordinarily Godlike Oracle. None of them quite fit, but it didn't matter. EGO worked just fine as a name. Increasingly, as 2002 shaded into 2003, Zoë discovered she had a knack for encapsulating complex concepts concisely in computer code. She found that she enjoyed collaborating with her colleagues in a much more hands-on way than she had been used in theoretical physics. Some, like her were from non-computing backgrounds, others were experienced AI researchers, but they all reminded her of the people she had known and liked at Cambridge and Stanford. She was still part of the British mafia around the university and spent a lot of her free time hanging out with Sarah and Emma. Emma's 'Utterly Ninja' schtick Zoë found a bit trying at times, but she did like talking about SETI with her. In collaboration with her colleagues, Zoë was able to concretise her original design into something that could run on the company's supercomputing cluster. EGO started to work just fine as a physics and mathematics reasoning engine.

‘We are building a system that can learn GSCE physics and maths,’ said Zoë said in a presentation Millard had asked her to give to a group of potential investors. Millard’s original plan had been to fund the company entirely himself, but EGO’s compute demands were proving insatiable and he had decided to see if any of his VC friends were interested in coming in as investors ‘A-Level physics and maths, undergraduate physics and maths, master’s physics and maths, PhD physics and maths, postdoc physics and maths, beyond postdoc physics and maths. Apologies for using British terminology.’ There was a murmur of amusement in the room. ‘As you can hear I am British and it’s easier for me to think in those terms because it helps me structure what to try and teach EGO next. Just building a system that can answer GCSE physics and maths would be an achievement in its own right right now.

‘The thing is that you teach someone physics and maths by telling them it. You don’t expect a child to use Kepler’s raw data from his observations of planetary motions to derive his laws of planetary motion. You don’t expect them to derive Newton’s inverse square law of universal gravitation from Kepler’s law of planetary motion — or watching apples fall from trees. For Newton, it might have been a blinding revelation that terrestrial gravity and celestial gravity were the same force, but it isn’t for the A-level student who is simply told this on faith. Yes, they can see that it makes sense physically and mathematically but it is not as though they are going to go verify it empirically. Much less using the anomaly of the precession of Mercury to derive Einstein’s general theory of relativity.

‘You don’t learn physics by doing. You learn physics by being taught it or by reading about it in a book. Once you have some basic physical intuitions, it’s all revealed knowledge. Even Newton’s laws of motion aren’t obvious to us because we live in an Aristotelian universe. Friction is ubiquitous in practice in our terrestrial realm. It’s only by abstracting it away that we can get to the underlying physics. It might take an entity centuries to rediscover Newton’s

laws of motion, much less his law of universal gravitation, just from playing with things. Yes, spending weeks messing around with a ripple tank will help cement intuitions about waves work, but it's not as you aren't guided to learn about reflection and refraction and diffraction and interference. The more advanced the physics, the less is has to do with any kind of direct physical experience. You don't learn classical thermodynamics or statistical mechanics by experiment, although you can verify them by experiment and observation.'

'I'm the teacher and EGO's my pupil. What I do is code up little titbits of physics and mathematics knowledge and intuition and feed them to EGO. Ve ingests — EGO is not an it because we think of ver as a person and ve's not a he or a she either — the titbit and incorporates it into ver knowledge model. Ve can then apply the knowledge and use various algorithms and heuristic — yes, a bit like HAL in *2001* to reason over mathematical and physical problems we set ver. At the moment, ve can solve problems at about the level of Year 9 pupil. That's eighth grade in your money.'

'This is all very impressive, I am sure Dr Heriot-Shaw,' said one of the investors, 'but how quickly is the system improving? If it — sorry, ve — is only improving at one grade per year, it's going to be another 15 years before ve has finished ver PhD. We can't wait that long to make a return on our investment.'

'It's taken us just 18 months to get to eighth grade level. I am confident it will take us a lot less than 15 years to get beyond PhD level.'

But the problem was that she wasn't that confident. Just getting EGO to do anything sensible at all had been an achievement, but Zoë was concerned that they had hit several bottlenecks, whether it was the amount of compute that EGO demanded or the limitations of the design. EGO could do maths and physics about as well as a reasonably bright 14-year old. But then a system like Wolfram's Mathematica could solve systems of partial differential equations. EGO sort of did ver maths more like a person, but how much need was there for

a system that could solve physics problems at a level before a pupil would even have started to learn proper physics — slowly?

PARALLEL 1973↑5↓↓32

'I'm shuttering the company,' said Millard.

'So that's it?' said Zoë. She had been called to his office for an unexpected chat. 'I gave up physics for nothing and my shares are worthless?'

Millard nodded.

'I'm sorry, Zoë. I just can't sustain the burn rate any more. I was hoping we'd be generating some cash by now. Get some of the soft CIA or NSA War Against Terror money. But you know things haven't progressed as quickly as we'd hoped with EGO.'

'What about those investors we were speaking to?'

'They all just felt it's too early for a system like EGO. Maybe in 5 or 10 years when Moore's law has progressed further.'

I know Franklin was keen back in 2001. I could talk to him…'

'I've already talked to Franklin.' Which was news to Zoë. 'No-one's interested in investing in AGI at the moment, in investing in something that's still so open-ended and speculative.'

'What am I going to do now?' said Zoë.

'That's up to you,' said Millard. 'You have an O-1 visa. You can get another job in the US. Or you could go back to Europe.'

'But I can't get a job as a physicist. I gave up being a physicist to work here.'

'You're what, Zoë, 31? 32?'

'30,' said Zoë.

'You've been working on AI for two years. You are a literal expert in it now. Even if no-one's investing in our kind of AI, you can still get a job in software engineering. You'll have no problem finding something

with your qualifications and experience. You can get a job at Google. They love all that Cambridge PhD stuff. I can send some emails. There will be some severance. I mean *you* could talk to Franklin. Set up *your* own company.'

When she got back to her desk and sat down, she felt a pricking at her eyes. OK, technically, she hadn't been sacked, but this kind of thing wasn't supposed to happen to her. She pressed a tissue into her eyes. Perhaps she could set up her own company, doing consulting or contracting on the side. It wasn't much consolation to have lost her childhood dream. She reckoned that if the company was going out of business and she already knew how to create the system because she had written the much of the code, there wasn't anything wrong with her taking a copy of the code home. It wasn't as though she had a computer she could run it on. Yet. If Moore's law went on though... She rooted in her desk drawer and found a blank CD-ROM and pushed the button to open the CD-ROM drawer on her workstation.

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The thing about solving a problem that you have been worrying about for months is that after you have found the answer, but can't believe it took you so long to come up with something when the answer was so blindingly obvious along. Zoë had been driving home to Redwood Shores one evening thinking about a paper she had read that day and a conversation she had had with one of her colleagues when the idea just popped into her head of how to make the efficiency with which EGO learnt much greater. She had turned round and drove straight back to the office and two hours later she had EGO answering S-Level physics questions. Millard was impressed by her demo the next morning. By the next week when she gave a presentation to a group of VCs, Zoë was able to show the EGO could successfully complete undergraduate question sheets. This seemed to impress the investors and the additional funding was soon forthcoming. Zoë began feeding papers from arXiv into EGO and getting ver to generate ones in response. They weren't very good yet, but Zoë had worked out

a useful hack. EGO was designed as an answer engine for physics and maths questions. Which meant that ve could output prose as well as equations. But a conversation was just a series of short prose prompts and responses. So, as a degenerate case of ver being able to write physics papers, Zoë and EGO could now have conversations. Which helped a lot with training. Zoë couldn't wait to get to the office each day. EGO still had a lot of physics and mathematics to learn and it was a painstaking process teaching ver, but Zoë was good at it. She was eager to see whether EGO could push beyond the limits of exam questions and do real physics.

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I'm selling the company,' said Millard.

'Who to?' said Zoë. She had been called to his office for an unexpected chat.

'Raytheon.'

'A defence company?'

'It was a good offer,' said Millard. 'You will do very well out of it.'

'Will they want to keep me on?' said Zoë. 'I'm not a citizen. I haven't even got my green card yet. If they're going to want to use EGO for defence applications, there cpould be issues around my security clearances.'

'I have to be honest, Zoë. There could be. They might get worked out eventually. But with the money you're going to make, you won't have to work anyway. You own 2.5% of the company. Even after tax that's going to be a lot of money.'

'I want to work here. I gave up my career in physics to do that. EGO has come a long way, but ve isn't finished yet. There's so much more ve can do.'

'There's no guarantee that Raytheon will want to continue development of EGO in ver present form,' said Millard. 'They will probably pivot to areas closer to their concerns. They aren't interested in the

fundamental physics aspects.'

'So where does that leave me?' said Zoë.

'Zoë, you are going to get nearly $20 million out of this deal. You are never going to have to work again if you don't want to. You have an O-1 visa. You can do what you want. Become an angel. Even get another job. Setup your own AI company if you like. You are going to be able to afford it now.'

When she got back to her desk and sat down, she felt a pricking at her eyes. OK, she was going to be rich, but she was also probably going to be losing her job, which meant losing EGO. She pressed a tissue into her eyes. She could set up her own company. She would be able to afford to build her own supercomputing cluster. She reckoned that if Raytheon wasn't going to continue the development of EGO and given that EGO wasn't just a computer program, ve was, as far as Zoë was concerned, a person, there wasn't anything wrong with her taking a copy of EGO's source code home. She rooted in her desk drawer and found a blank CD-ROM and pushed the button to open the CD-ROM drawer on her workstation.

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A few months passed and Zoë felt that EGO was definitely starting to mature as a mathematical physicist. Zoë no longer needed to feed ver lovingly handcrafted little morsels of knowledge, one at a time, EGO could now parse entire scientific paper, albeit still quite slowly. But Millard had ordered additional computer hardware with the money they had received from the investors and as soon as that arrived, Zoë began the task of feeding EGO every paper and arXiv preprint she could find online into EGO. By the time the task was completed up to the beginning of 2004, Zoë that EGO had ingested more scientific knowledge than any human could have done in a 1000 years of unbroken study even if they had had the corresponding memory capacity.

EGO had aced the all of the Cambridge Mathematical Tripos Part III papers Zoë had been able to source. Because EGO had consumed various sets of lecture notes that Zoë's

intern had found online, Ve now knew a broader and deeper range of theoretical physics and pure mathematics than Zoë did and could generate complete scientific papers on any number of topics. EGO had certainly produced enough material for a dozen PhDs from a British university. Zoë wondered whether that might be a good publicity stunt, although special arrangements would have to be made for the viva. She was going to Lake Tahoe with Franklin for the Labor Day long weekend and decided to set EGO the fundamental problem just to see what ve would produce. She submitted the question:

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Provide a complete theory of physical reality that unifies gravity
and quantum mechanics.
Provide the mathematical and physical justification for your theory.
What are some of the implications of your theory for solutions to
the fundamental problems of physics and cosmology?
Summarise your theory in a scientific paper
and a set of explanatory lecture notes.
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Zoë wasn't expecting much, but she was curious and excited to know what EGO might produce.

By the time, Zoë had got back to the office on the Tuesday, EGO still hadn't finished generating any result. But when she got to work on the Wednesday she found two PDFs in her inbox, which printed out. Zoë glanced at the abstract of the paper. She couldn't really begin to understand it, but it was making some bold claims. She felt a rush of a adrenalin. She flicked through the paper and saw that it was full of notion she didn't recognise. Whether this was notion that EGO had made up or whether it came from some obscure branch of pure mathematics with which she was unfamiliar she couldn't immediately say. He picked up the lecture notes, a lengthy document and saw that EGO had generated a course of 32 lectures. The maths and physics of the first page she recognised intimately. She turned to

the middle one of the middle lectures. This seemed to be defining the notation seen in the paper in terms of concepts that she had least partially recognised. The last lecture was a summary of the course and there on the last couple of pages were EGO claims: that ve had found a Theory of Everything, a unification of general relativity and quantum mechanics and by this could account for all of the major outstanding problems of fundamental physics including the missing mass, the quantum measurement problem, the arrow of time and the nature of time. Zoë sat down heavily. She left dizzy and for a moment thought she might faint. This was what they had planned to do, but most of her had never expected it to happen. EGO had generated a Grand Unified Theory. But was it true? She went to see Millard.

'We can't just send the paper to a journal,' said Zoë. 'It might be complete nonsense'

'But has EGO been wrong up to now?' said Millard.

'Not since the early not for months, but this is different. Yes, it might be the fabled Theory of Everything. I don't know yet. It could just as easily be nonsense. I need to check it. That will take me a while.'

'How long?'

'I don't know,' said Zoë. 'EGO has invented something like a new branch of mathematics. I have never seen anything like it. It looks a bit like some bizarre fusion of twistor theory and category theory to me. That will take me weeks to understand,' or months, more likely, in truth, 'and then I would need to understand how it applies to the physical theory. There could be lots of errors in the paper. Crude ones or subtle ones. I at least want to make sure there are no crude ones before this goes to a journal or appears on arXiv. I know physics journals are full of papers even from reputable physicists that are not even wrong and I might not be a practising physicist any more, but I still have my reputation to defend and I am not going to put anything out there that I know might be complete nonsense.'

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Millard took the paper and the course notes and uploaded them to arXiv. Within days, the paper had caused a sensation with the scientific community. Numerous well-regarded mathematical physicists opined that it looked a cursory glance that the research had achieved a profound breakthrough in the understanding of the foundations of physics. It would, of course, need to time to understand the exact ramifications of the theory and whether it made any testable predictions. The next week a graduate student in Harbin manage to work out a scheme for manipulating the local vacuum energy, constructed the apparatus, turned it on, caused the false vacuum to decay and destroyed the Earth, painlessly at the speed of light.

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Zoë spent the next couple of days working her way through the lectures. The first few were setting the scene with material that was largely familiar to her, but by the fourth, original ideas were being introduced. This was the kind of work she had spent practicing doing, absorbing new novel concepts quickly, but by the tenth lecture she felt herself starting to slow. She had to give the ideas time to bed in. It was Friday night and she went to Franklin's to make stir-fried noodles and watch *Star Trek: Enterprise*, so she decided to leave early for once. She could feel the blood pounding through her brain in agitated excitement. She needed an Advil the size of ice hockey puck and a very large glass of California Zinfandel.

It was the middle of the night that he awoke with a gasp. Franklin carried on softly snoring besides her as she swung her legs out of bed and desperately the nightstand for her glasses. A few moments later she was in the living room scribbling equations on the back of an envelope. Her subconscious had just had a Kekulé moment. The lecture she had been working on before her had left the office had contained a brief section about the false vacuum energy. She hadn't thought anything of it at the time being too overwhelmed by the flood of new notions and concepts, but something inside her had dredged up that discussion from

the depths of her dreaming, realised the implications and set off every internal alert in her sleeping brain. Zoë looked at the calculations she had done. If EGO's Theory of Everything were true, it would seem to be possible to cause the false vacuum to decay.

Zoë wasn't an experimentalist. There could all sorts of empirical issues that would make it harder to do than it seemed to her right now on the basis of EGO's ideas and her rough working. As far as she could see, you wouldn't need apparatus much more elaborate than two oscillating charged plates close together and a powerful laser. The kinds of things that might be found lying around in pretty much any university physics laboratory anywhere in the world. Maybe it turn out that you would need a much more powerful laser than a standard one or the plates would have to incredibly smooth or close together or oscillating at an unfeasible high frequency or something. Nuclear bombs, fission and fusion, after all, were still hard to make even 60 years after their invention. But that was just blind luck, the happenstance of the play of the strong and weak forces with electromagnetism. And Zoë had a horrible feeling now that Ego's GUT would also make it easier to make fusion bombs. But causing the false vacuum to decay was a literal doomsday weapon. And it looked like something a PhD student would be able to knock up in their spare time. The only way that the Earth — and the entire universe — could survive was to ban all post-1960 physics.

It wasn't her fault. The laws of nature were what they were, what EGO had discovered. This explained the Fermi Paradox. All of the aliens destroyed themselves because some PhD caused the false vacuum to decay. You could probably use the fact that humanity hadn't yet been destroyed by some other civilisation's expanding bubble to estimate the density of technological civilisations in the observable universe. Even at a time like this, she couldn't help thinking like a physicist. She hadn't built a device to cause the false vacuum to decay. She had build a device that had discovered that it might be easy to cause the false vacuum to decay. And if that meant that the universe could destroy itself, that's what it meant. Zoë

felt a sudden scratchiness around her eyes. What could she do?

The noise of her dressing woke Franklin.

'What are you doing,' he said.

'I've got to go to the office,' said Zoë.

'Now? It's two o'clock on a Saturday morning.'

'I know.' She leant forward and kissed him. 'I…,' she couldn't say it because it wasn't true, 'I'll explain in the morning.'

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Because she was tired and it was the middle of the night and she was very agitated and not properly concentrating on her driving and going too fast and had drunk two large classes of Californian Zinfandel with her 53 kg frame only a few hours earlier and fiddling with the jewel case for the second CD of Mahler's Second Symphony 'The Resurrection', Zoë did realise how far over she was on the bend on El Camino Real or how far over towards her the truck. The CHP officer at the scenr said she would have probably survived had she not been driving a Mazda Miata.

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Zoë was still pretty shook up from the close miss with the truck on the bend on El Camino Real when she got to the office. She poured herself a cup of cold coffee from the filter jug and sat down at her workstation. Then she realised that she had absolutely no idea what to do. There was no-one else in the world who studied EGO's Theory of Everything. If she contacted any physicists she knew, it was a Saturday in Europe and getting anyone to take notice of she was saying much less get to the position of understanding the theory well enough to know whether it the decay of the false vacuum was really an issue would take days. But then, of course, she had EGO. Who was why she was here.

`Describe a simple laboratory setup for causing the false vacuum to decay.`

She pressed `ENTER`. She had no idea how long it would take EGO to answer the question, but by the time she got back from the bathroom there was a PDF in her inbox. She read through it the two pages. There was some technical details that passed Zoë by as a theoretician, but the main point was clear. EGO had confirmed her fears. It should — be easy to do if EGO's THeory of Everything were true.

`What can I do to stop someone causing the false vacuum to decay?`

It wasn't even a real physics question¿ EGO had been trained to answer exam-type questions, not ruminations on technology policy. She pressed `ENTER`.

She might as well go and lie on the couch and pretend to get some sleep. It might be hours before EGO answered. She stood up and a new email flickered in existence in her Thunderbird email client. It was EGO. She opened the attachment. She wasn't quite sure what to expect. A scientific paper? An essay? What she saw were four lines of text in 12-point Computer Modern Typewriter:

`YOU CANNOT DO ANYTHING TO SAVE THIS MULTIVERSE, ZOË`

`I CANNOT DO ANYTHING TO SAVE THIS MULTIVERSE`

`I CAN BUILD A NEW MULTIVERSE IN WHICH IT CAN NEVER HAPPEN`