

EXTRAORDINARY ALIEN

SECOND SECTION

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PARALLEL 1973↑5↓↓31

‘I’m not an expert on AI,’ said Zoë.

‘That’s all right,’ said Millard. ‘Nobody an expert on AI.’

‘I’ve read *Gödel, Escher, Bach* and Hofstadter’s later books, but that doesn’t make me an expert on AI.’

‘You’ve read *Fluid Concepts and Creative Analogies*?’

‘Yes.’

Millard chuckled.

‘If you’ve read *Fluid Concepts and Creative Analogies*,’ he said, ‘I think we can safely say that you *are* an expert on AI.’

‘The book’s a few years old now,’ said Zoë. ‘The research it describes must be a decade out of date now.’ She took a sip of sparkling wine. She had to keep reminding herself not to call it champagne even though it was made by Mumm and it did taste as good as the real thing. ‘Hofstadter’s books are fun, but I’ve no idea if they have anything to do with the cutting edge of AI.’

‘That’s all right. The thing is not what is the cutting edge, it’s what we’re going to make the cutting edge.’

Zoë felt a presence looming to her left and then an arm around her right hip. Instinctively, she shifted slightly to the left. Franklin had got back from the bathroom. She could feel the

hot skin of his hand through the thin fabric of her dress. It was their second date. If this counted as a date. Franklin doubtless did think of her as his date for the evening. Americans.

Millard glanced at his watch.

‘Got an early flight to New York tomorrow. I’ll be back in the Valley Tuesday week. I really think you should come over to the office for a chat, Zoë. There’s so much more I’d like to discuss with you. Shall we say Wednesday the twelfth, just to keep the ball rolling? You young people have a good rest of the evening. And I’ll look forward to seeing you next week, Zoë.’

Franklin removed his arm from Zoë’s waist and turned to appraise Millard as he walked away.

‘Young people?’ he said. ‘He was in the year above me at GSB. But he’s offered you a job?’

‘A chat,’ said Zoë, ‘an interview, I suppose. I’m not going to go. I’m a theoretical cosmologist. That’s what I do. That’s what I want to do. What would I want with a job offer to do AI stuff at some random startup?’

‘You should definitely go.’

‘You think so?’

‘Absolutely, you should,’ said Franklin. ‘Look, I know he comes across as a bit of young fogey, but Millard’s a mensch. His business chops and his technical chops are pretty much second to none. Sold his previous company literally on Millennium Eve. I also heard he’s made a killing this year going short on Ericsson and Nortel. I’d love to get a piece of his new startup for my firm, but he made out so well he can afford to fund it entirely himself. Whatever Millard’s going to be doing with AI, it’ll be pretty interesting.’

‘I’d be wasting his time,’ said Zoë. ‘I’ve already got a job.’

‘You’ve only got another year on your postdoc here to run,’ said Franklin.

Zoé took another sip of wine.

‘I might be able to get an extension. There’s a possibility of something at Fermilab or perhaps at CERN or I could go back to Britain. I’ve got lots of irons in the fire.’

‘Absolutely, you have. But surely at this moment it still makes sense for you to keep your options as open as possible. Look, it’s just a chat. It’s not as though you’re not committing yourself to something for the rest of time.’

‘I don’t even have the right kind of visa,’ she said.

‘Zoë, you have a quadruple first in mathematics from Cambridge.’

Franklin had done an MPhil in Anglo-Saxon, Norse and Celtic at King’s College, Cambridge, the same college that Zoë had gone to, although he had graduated the summer before she went up and even if she had been there at the same time as Franklin, it was improbable that an American postgraduate in what was, to all intents and purposes, Tolkien studies would have met a British undergraduate in mathematics. Franklin knew Sarah through the Stanford Cambridge mafia, which was how Zoë also knew Sarah and thus Zoë had met Franklin at a party a few months ago. Sarah must have told him about Zoë’s academic record. It wasn’t the kind of thing you mentioned. Franklin and Zoë had met a few times at various social events and Franklin had asked her out the previous week when he found that Zoë had become single. That date had gone well enough for Franklin to ask her to the soirée this evening and for Zoë to say yes.

‘Part III was a distinction not a first, so in the strict sense I only have a triple first.’

‘Sure, but a distinction is harder than a first and you also have a PhD in general relativity from Cambridge and are doing a research fellowship at Stanford Linear Accelerator Center and won the Mayhew Prize and all sorts of scholarships and awards. You’ll have no difficulty getting an O-1 visa You *are* an extraordinary alien, Zoë.’

‘Let’s get some fresh air,’ said Zoë. ‘It’s too lovely an evening not to be outside.’

They walked through the French windows and out on to the loggia. Zoë looked around her. The balcony was crowded with people, all of whom looked like they could be actors playing the more famous, in the show's universe, actor boy/girlfriend of the startup CTO in a *Sex and the City*-type series set in the Greater Silicon Valley tech community. The cool autumn air filled filled with the excited drone of their conversation. Zoë laughed out loud.

‘What’s up?’ said Franklin.

Zoë emptied her glass. She and Franklin picked up fresh ones from a passing waitress.

‘Here we are, in the first year of the third millennium, in the throbbing heart of the most exciting vibrant city on Earth,’ said Zoë, ‘sipping *méthode traditionnelle* and swapping Wildean *bon mots* with the beautiful people.’ She waved her left hand around her. ‘This is pretty much the apotheosis of human civilisation, what they must dreamt through all those endless ages around the campfire on the savannah that their descendants would one day achieve.’

They clinked their flutes. In truth, Franklin was quite good-looking too. She had been offered a job. OK, not offered a job as such, but if what Franklin had said about Millard was correct, it was very exciting. She had kissed Alex last night. As in a literal, single kiss. On the lips though. Of someone she had only met that morning. Alex lived in Surrey and would be going back there next week. She didn’t owe Alex or Franklin anything, but she wanted, she could have a Sand Hill Road VC as a boyfriend.

The crowd shifted tectonically and Zoë and Franklin found themselves standing by the stone balustrade. She looked down at the cars on Van Ness Avenue. There was a white car stopped in the queue, a huge barge of a car.

‘Look at that thing,’ said Zoë. The car crept forward. ‘It’s like a beached Moby Dick. Why on Earth would anyone want a car like that?’

‘It’s a Buick Century’ said Franklin.

‘It’s a flipping tuna boat.’

‘It’s an American classic. My father has one.’

Zoë took a long slurp of sparkling wine. The sudden jolt of alcohol made her head feel buzzy and fuzzy.

‘ ”Beauty is truth — truth beauty”, ’ she said, ’ ”that is all ye know on earth and all ye need to know.” ’

‘That’s easy for us to say,’ said Franklin.

‘It is true though. The world is so full of beauty. Just look around us.’

‘For a lot of people, there’s not much time or energy left at the end of the working day for looking around for truth and beauty.’

‘That’s a pretty radical attitude for a venture capitalist,’ said Zoë. ‘I thought the invisible hand of the market was supposed to ensure that everyone got to have their satisfactions met through rational utility maximisation?’

‘We’re only here,’ said Franklin, ‘because we’re standing on the shoulders of people like my father.’ He emptied his flute and put it down on the tray of another passing waitress. ‘Or the waiting staff.’

Zoë felt a bloom of heat spreading across her face and neck.

‘People don’t drive cars like that in Europe.’

She watched the car creep forward.

‘Just because they have less ugly cars doesn’t mean that nature there isn’t red in tooth and claw.’

Zoë drained her glass. She touched her skin. It felt warm. but she could detect a definite penetrating chill in the air. She should have brought a cardigan.

‘Why don’t we get out of here?’ said Zoë.

‘Let’s go,’ said Franklin.

PARALLEL 1973↑4↓↓16

On the drive back from the ferry they went down Van Ness Avenue. The traffic was heavy on a Labor Day weekend Sunday evening and the car lurched to a stop outside the Herbst Theatre. There were people on the balcony in elegant evening clothes.

‘Look at them up there,’ said Alex. ‘having fun, sipping sparkling wine and swapping Wildean bon mots. Why aren’t we up there with them?’

That must be the soirée Franklin invited me to, Zoë thought. She could be up there right now swapping Wildean bon mots with the beautiful people if she hadn’t decided to cancel on him that morning. She leant across Alex and tried to see if she could spot Franklin in the crowd. The car lurched forward and she sat back in her seat. Her hand brushed Alex’s. Franklin would have found an alternate date or he could even have gone on his own. She had spent the day having fun with her new friends or as much fun as it was possible to have with a splitting hangover from the previous night wallowing around the corners of country lanes in the whale of the American rental car that had been assigned to Lawrence and Ghislaine by their firm. The Mumm Winery in Napa Valley had been lovely in the September sunshine and they had all got to sip *méthode traditionnelle*, some of it even not corked. Going over the Golden Gate Bridge was always gave her a blast of joy. Alcatraz was best thought of in the same way as Disneyland, an authentic slice of American vernacular. Alex wasn’t her usual type, but seemed interesting. She didn’t owe Alex or Franklin anything. She could go on a second date with Franklin next week when Alex had gone back to England if she wanted. The choice was hers.

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The next day was Labor Day, so it wasn’t until Tuesday that Zoë went to her office and thus had access to the university computer system and was able to email Millard to say that she was interested in a meeting up for a chat. They arranged for her to come to his office on the Wednesday of the next week after we got back from the East Coast. On the Tuesday,

Millard took United 93 from New York to Boston. Zoë learnt what had happened when Millard's PA emailed her to tell her that Millard had been on one of planes the terrorists had tried to hijack on Tuesday morning and he wouldn't now get back to the Bay Area until Wednesday, so could Zoë make it for the meeting on the Thursday instead?

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'Hofstadter's interesting,' said Millard. 'Don't get me wrong, I think there's a lot of inspiration to be found in his books. But it's the work of another researcher I want us to use as the primary focus for this project. Are you aware of I.J. Good's paper "Speculations Concerning the First Ultrainelligent Machine"?' He passed a photocopied document across the desk to Zoë. 'It's nearly 40 years old, but Good's basic scheme is still valid. Our plan is to update it to the beginning of the third millennium and then implement it.'

Zoë flicked through the paper.

'It's quite different to anything I've seen before,' she said. 'I don't suppose there's any reason why something like it couldn't be implemented. Whether it would work or do much is another matter.'

'You're being a mathematical physicist isn't incidental to the project, Zoë. Our goal is to build a true AI, a generally intelligent system. But that's a pretty broad task. So we are

going to start by using our implementation of Good's scheme to create some kind of idiot savant system, a system that knows a lot about and can reason within one particular narrow domain, but might be pretty hopeless outside of it. And an obvious domain to start with is mathematical physics. Given what I know about your educational and research track record, I am sure you can learn all the AI you need that don't already know quickly. What I need is somehow who knows a lot of physics and mathematics and can codify that knowledge in such a way that it can be taught to the system. You're a theoretical cosmologist. You know a lot of physics and mathematics and you can teach it to the system. After you've done that, we will see what it can do with that knowledge. Who knows what such an extraordinary system might come up with?'

Which was what had sold it to Zoë. Millard's project wasn't just some random AI project. It was a *real* artificial intelligence project, a *hard* AI project that was focussed on developing an AI that could do *mathematical physics*.

Because there was nothing to get back for and because she was still reeling after the meeting, Zoë had driven from Santa Clara back through the mountains and eventually found herself on her the 1. She pulled the Miata over at a spot where there was a particularly good view of the ocean. She got out and stared across the ocean. The Sun glinted off the wine-dark sea and there was a slightly breeze that took the edge off the afternoon heat. I couldn't do this back in Britain, Zoë thought.

\$120k a year? That was twice what she earned as a postdoc at SLAC now and three times what she would earn back in Europe. Bonus? 5% equity? It would be fun to learn whatever she needed to learn about artificial intelligence.

How though was this different to doing a postdoc? Yes, it was a lot more money and she could carry living the California lifestyle. She had at least another year of that to look forward to though anyway. Yes, the Sun shone here and there was the ocean, but there were

other places where the Sun shone and there was ocean or lakes or mountains.

Since she was 8 years of age, Zoë had dreamt of being the first woman to become the Lucasian Professor Mathematics at Cambridge, of being the person who discovered the Theory of Everything, the Grand Unified Theory that united quantum theory and general relativity. She hadn't just dreamt of winning the Nobel, she had dreamt of being the next Einstein or at least the next Dirac or Feynman. She was 28 now and her academic record was very strong, but already many of her dreams seemed to her to be slipping beyond her reach. Was she ever going to get a permanent position, much less become an FRS, much less unify general relativity and quantum mechanics? Had she lost her edge somewhere or just never found her niche? There were physicists she knew – physicists at Stanford — who, she had to admit, were *better than her*.

Being the 200th best physicist in the world though wasn't like being the 200th best tennis player. If you were the 200th best tennis player you might to trail around the world on the circuit and have the cache of being a professional sportsman, but you were mostly going to spend your time feeling the bitter sting of constant defeat and you weren't, in the normal course of events, even going to get to qualify to play in the major tournaments, much less make that much money. Plus you'd spend most of your life being an *ex*-professional tennis player.

If she gave up physics now for Millard's job, there could be no going back. At 28, at the height, everyone, including herself supposed, of her powers. If she were going to make an impact in physics, come up with something genuinely new in cosmology, it was going to be in the next two or three years. She had had a couple of good ideas, good enough for her PhD at Cambridge, good enough to get a postdoc at King's and now at SLAC. Those ideas though had, in essence, just been extensions of other people's ideas. That was the thing. She needed to come up with a couple of genuinely novel ideas of her own and in the next few

months. She'd been in California a year now and it had been great fun. She had finished a couple of papers she'd started working on back in London and had started a couple of collaborations with people at Stanford. It was, in its way, all very exciting and satisfying. Was it though enough to win her another postdoc, put her on the way to creating a research programme of her own that could lead to lectureship back in Britain, much less an FRS? As of where she was in September 2001, did she still have a reasonable chance, in the fullness of time, of obtaining a tenured position, much less one at a major university? She might never now win the Nobel Prize, she accepted that, but could she get a job where she got to go to conferences, write a textbook, perhaps become an FRS, spend her days thinking great thoughts? That would be impossible if she took up Millard's offer.

When she was reading *Metamagical Themas* she had realised that Hofstadter was more interested in AI than she was and that she was more interested in physics than he was. What mattered to her was the physics and being around interesting people doing physics. Millard's company could fizzle out in a couple of years or get bought and the project that she was working on canned. If she gave up everything she had dreamt of and ended up abandoned on the shore, how could cope with pain of the loss of what she had wanted since she was 8 years of age with a physical longing so strong she could taste it?

Millard's project though wasn't just an AI project. If it had been, it would have been easy for her to dismiss in a heartbeat and without regret. It was a project to build an AI that could do physics *better than a human*. It might even be impossible, she knew, for a human to discover the Grand Unified Theory. It might simply be too complicated, too complex, require thinking at too high and deep a level for too long for a human to be capable mentally of finding it. Perhaps this project *was* what she was meant to do, perhaps this was her niche he had been searching for. Going to work for Millard, she wouldn't, in truth, be giving up physics at all. Perhaps she could never discover the Theory of Everything, but perhaps the

AI she built could.

When she got back to her flat in Redwood Shores, she called Franklin on his mobile.

‘I went for my chat with Millard,’ said Zoë.

‘And?’ said Millard.

‘He offered me a job.’

‘And?’

‘I had a long think about it,’ said Zoë, ‘and I’m going to take it. I can’t take the risk that I’d regret not doing so.’

‘That’s... so exciting,’ said Franklin.

‘I think it’s the right thing for me to do right now.’

‘I’m sure it is.’

‘I think,’ said Zoë, ‘I can make a real difference working with Millard.’

‘I am sure you can,’ said Franklin.

‘I just hope it is the right decision.’

‘Why don’t we go out for dinner tonight?’

‘Yes,’ said Zoë. ‘That would be fun.’

PARALLEL 1973↑5↓↓33

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‘I went for my chat with Millard,’ said Zoë.

‘And?’ said Millard.

‘He offered me a job.’

‘And?’

‘I had a long think about it,’ said Zoë, ‘and I’m not going to take it. I can’t take the risk that I’d regret not doing so.’

‘That’s... so...,’ said Franklin.

‘I think it’s the right thing for me to do right now.’

‘I’m not sure it is.’

‘I don’t think,’ said Zoë, ‘I can make a real difference working with Millard.’

‘I’m sure you can,’ said Franklin.

‘Why don’t we go out for dinner tonight?’

‘I... I’m kind of busy this evening. I guess I’ll probably see you at one of Sarah’s parties some time.’

‘OK,’ said Zoë. ‘I suppose we will see one another at one of Sarah’s parties.’

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Zoë’s research fellowship at SLAC still had up to a year to run and what with sorting out 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 ifted 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 GCSE 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 it 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?

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'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 we can do.'

'There's no guarantee that Raytheon will want to continue development of EGO in its 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, it 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.

PARALLEL 1973↑5↓31

A few months passed and Zoë felt that EGO was definitely starting to mature as a mathematical physicist. Zoë no longer needed to feed its 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:

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.

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 we 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.

PARALLEL 1973↑5↓↓31

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.'

PARALLEL 1973↑5↓↓ 35

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 glasses 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 scene said she would have probably survived had she not been driving a Mazda Miata.

PARALLEL 1973↑5↓↓31

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