pre-industrial levels, the Intergovernmental Panel on Climate Change (IPCC) has warned, "climate-related risks to health, livelihoods, food security, water supply, human security, and economic growth" will increase. Warming beyond that point to just 2.0 °C will further harm hundreds of millions of people in vulnerable areas worldwide, the IPCC estimates. Yet the emission levels countries have volunteered to aim for following the Paris agreement will warm Earth by approximately 3.0 °C over the next 80 years alone, and it seems that even these goals will not be met.

This failure of the global political establishment to adequately address climate change has prompted a hunger for some sort of transformative breakthrough, either of the political or of the technological kind.

Our best hope for the former — already expressed in a global wave of climate activism — might be an unprecedented political movement which dramatically ups the pressure to act more determinedly in the face of a crisis.

Our best hope for the latter is called nuclear fusion.

Nuclear fusion is a process by which pairs of light atomic nuclei unite while releasing enormous amounts of energy. It is the mechanism that powers the Sun and other stars, and a principle that researchers have long hoped to harness to build nuclear-fusion power plants. In theory, such plants could be fuelled with sustainably sourced hydrogen isotopes for thousands of years, while being safer than nuclear-fission plants and producing zero long-lived nuclear waste. Unfortunately, they also come with a catch: building them is incredibly hard.

This is because nuclear fusion on Earth requires temperatures in the order of tens of millions of degrees Celsius, at which the fusion fuel behaves as a riotous plasma. The difficulty in governing the behaviour of this plasma is the key reason why nuclear-fusion power plants do not exist today, despite over sixty years of extensive research. Nevertheless, those years have resulted in many valuable insights, and a clean-energy future thanks to nuclear fusion seems more realistic today than ever before.

The most ambitious nuclear-fusion project to date, ITER, is currently being constructed in southern France with the explicit goal of pushing past break-even, a so-far elusive point of operation at which the output power of the fusion process exceeds the power invested to maintain the plasma. Helped by dozens of other labs around the world, ITER, which is scheduled to start full operation in 2035, will also test several auxiliary technologies that a working fusion plant would ultimately require, all while separate research into competing types of fusion reactors continues elsewhere and breakthroughs such as deep learning advance the field (J. Kates-Harbeck *et al. Nature* **568**, 526–531; 2019). With all this in mind, I'm hopeful that working nuclear-fusion plants will be built well before the end of the century, and that fusion energy will help substantially in limiting the impact of the climate crisis.

Irrespective of that crisis, there are plenty of other reasons to be excited about nuclear fusion. As a physicist, I am humbled by the idea of taming a plasma that is several times hotter than the Sun's core. As a researcher, I am amazed by the complexity that a nuclear-fusion power plant would require in every aspect of its ultimate design. And as a writer, I marvel at the prospect of mimicking the stars, instead of merely looking up to them.

"As a physicist, I am humbled by the idea of taming a plasma that is several times hotter than the Sun's core."

But it is as a human, thinking of other humans, that I feel a breakthrough in controlled fusion could rise above all else. After all, the human cost of climate change, of rising seas and rising temperatures, of more frequent droughts and extreme weather events, will ultimately have to be paid. And it will be paid first and foremost by those who have the least; by the poor and the less privileged, who can be faulted for the crisis they will be caught up in no more than a one-year-old boy can be faulted for electrocuting himself.

Nuclear-fusion power plants, more so than any other technology, could prove a uniquely powerful tool to diminish that cost.

That's why I hope to see them in my lifetime.

Robert Schittko is an experimental physicist at Harvard University, Cambridge, Massachusetts.

Reproduction, rethought

Same-sex partners should one day be able to raise a biological descendant together. **By Matthew Zajac**

One afternoon as a second-year undergraduate, I called my parents from my dormitory. To them it was a routine call home, but to me it was a conversation long overdue. I'd rehearsed with my closest friends exactly how to start; my words needed to strike with confidence but should mitigate shock. Like protecting them from a grenade I'd thrown at them.

"So … I actually do have some romance in my life. With a boy."

I practised answers to typical questions parents ask after their child comes out as gay: "Are you sure?", "Why haven't you told us?", "Didn't you like a girl once?" But those questions never came, and I wasn't prepared for the one my mom did ask: "What about kids?" Whether out of sympathy for my aspirations to raise children or because of her plans of pampering grandchildren, my mother quickly recognized that my ability to start a family could be jeopardized by

my sexuality. And she wasn't wrong; 74% of American adults are parents, but only 35% of lesbian, gay, bisexual and transgender (LGBT) adults are parents even though 51% express the desire to have children, according to a 2013 survey. As of 2015, two-thirds of minors living with same-sex couples come from a previous relationship. But this is changing. With homosexuality becoming more accepted in parts of the world, people are recognizing their sexual identity earlier and might be less likely to enter a different-sex marriage. As such, fewer same-sex couples are raising children, but those children are more likely to be born during a same-sex relationship.

This trend is partly due to increased opportunities for same-sex couples to parent, by adoption and other means. *In vitro* fertilization (IVF) and surrogacy offer partial genetic relatedness for same-sex female and male couples, respectively. However, neither of these options delivers full genetic relatedness. Although no evidence suggests that genetic relatedness is necessary or sufficient for parenthood, surveys of biologically infertile different-sex couples show its significance. In 2017, one study found that more than 97% of respondents would prefer having a genetically related child (S. Hendriks *et al. Hum. Reprod.* **32**, 2076–2087; 2017).

Now, as a graduate student performing research in chemical biology at the University of Chicago, Illinois, I think a lot about the intersection between my sexuality and my scientific interests. Genome-editing techniques are currently transforming our capacity to study fundamental biology. But, more importantly for me, they have offered a glimmer of hope that I could one day raise a biological descendant with my partner.

The road to same-sex human reproduction is one that many think is impossible to traverse. Aside from ethical and sociopolitical roadblocks, there are fundamental biological issues.

Parthenogenesis, or reproduction from an egg cell without fertilization, occurs naturally in birds and sharks. But mammalian reproduction is complicated by genomic 'imprinting', in which some genes are modified or shut down in either sperm or eggs while their opposite numbers are expressed — like the two halves of a zipper coming together. Seeking to address this, researchers have derived 'imprint-free' stem cells. A 2018 report in *Cell Stem Cell* described the use of CRISPR to delete imprinted regions from mouse genomes — removing the teeth from the biological zipper (Z.-K. Li *et al. Cell Stem Cell* **23**, 665–676; 2018). Use of this technique with eggs from female mice produced living pups that grew to be healthy, fertile adults. However, pups produced using the technique with sperm from male mice did not survive to adulthood. While a significant achievement, many see the low success rate of birth (14% with embryos from two mothers, 2.5% with embryos from two fathers) as proof that mammals are limited to sexual reproduction. However, the technique offers optimism that same-sex human reproduction may be possible with a better understanding of imprinting, among other advances.

The development of same-sex reproduction technology might in 2019 be a scientific fantasy, and its use would be controversial. But IVF and same-sex marriage would have been just as unthinkable in 1869, when *Nature* launched from a foundation of academic liberalism and bold science. The disruptive innovation of same-sex reproduction would simply continue this endeavour and provide children to capable parents, as long as it is investigated enough to eliminate risks, made financially accessible and regulated responsibly.

As for me, I aspire to give my parents a grandchild by any plausible means when my partner and I are ready. But to raise a child genetically related to me and my partner? That's a dream I'll always have.

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