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Antarctic split

The break in the Larsen C ice shelf highlights the vulnerable nature of other Antarctic environments and the impact that people are having on the continent.

It's winter in Antarctica, and dark. Only passing satellites can see the continent's latest giant iceberg. But news of the massive break in the Larsen C ice shelf, and the jagged section that now floats free, has raced around the world. Size sells. The chunk of ice has been described as twice as big as Luxembourg or Samoa, or about the size of Delaware.

Luxembourg and Samoa, unlike Delaware and the rest of the United States under the presidency of Donald Trump, are still officially behind the Paris climate agreement, which among its goals seeks to limit temperature increases in order to keep more of Antarctica together. Iceberg calving is a natural and ongoing process: Antarctic ice is constantly squeezed towards the edges of its rocky base by its own enormous weight, and some breaks off from time to time. This week's arrival of the Larsen C iceberg, which some climate campaigners are trying to name after the oil company Exxon, cannot be connected directly to our warming climate.

The same can't be said about the Thwaites Glacier: a gigantic hulk of frozen water that sits brooding and unstable further inland. Part of the mighty West Antarctic Ice Sheet, the fate of the Thwaites Glacier is what keeps most polar scientists awake at night. Most suspect that they know how its story will end, and the real question is, as the title of a review in April on the science of the glacier puts it: how much, how fast? (T. A. Scambos *et al. Glob. Planet. Change* **153,** 16–34; 2017).

In the past decade, measurements show that Thwaites is changing more rapidly than other similar environments. It is melting faster, sliding faster towards the sea and pushing sea levels higher. The system, scientists say, is a textbook case of a potentially unstable marine ice sheet. If greenhouse-gas emissions continue unchecked, Thwaites could survive for centuries or it might go in a few decades. If and when it fails, it could trigger a wider collapse of the rest of the western Antarctic ice reserves. It won't take satellite images for the rest of the world to notice the effects of such a collapse. The West Antarctic Ice Sheet contains enough water to raise global sea level by 3 metres.

While society ponders the future impact of Antarctica on people's lives, it's worth highlighting the way that people are already changing Antarctica. Presented as remote and pristine, in many ways the continent remains untouched. But, numbers of visitors are soaring and, however careful they are, they leave behind more than footprints in the snow.

Using figures for fishing crews, tourists and researchers, an analysis in April estimated that the number of person days spent on the Southern Ocean or Antarctic coastal regions swelled from 1.5 million in 2004–05 to 2.6 million in 2013–14 (C. L. Waller *et al. Sci. Total Environ.* **598,** 220–227; 2017). Most take specialist clothing made of synthetic materials. Many take toiletries and medicines. Some take recreational drugs.

We know this because a suite of surveys show that Antarctica is full of human litter. The sea bed in Terra Nova Bay is spotted with fragments of plastic including polyethylene, polypropylene and polystyrene. The shallow waters above swim with fragrance chemicals, chiefly amyl and hexyl salicylate, which are commonly used in soap, hair spray and fabric conditioner for their 'floral and herbal odour'. Meanwhile, the sea north of the Antarctic Peninsula, where the Larsen C iceberg could soon visit, is contaminated with drugs ranging from caffeine and ibuprofen to benzoylecgonine, a metabolite of cocaine. The strong circumpolar ocean currents around Antarctica normally seal the Southern Ocean off from the rest of the world's seas, so scientists think that most of these marine pollutants were released by visitors. One of the biggest sources is their clothing: a typical laundry load of fleeces and specialist waterproofs can liberate more than 728,000 synthetic fibres.

"However careful visitors are, they leave behind more than footprints in the snow."

Another visible impact, almost certainly down to the warming climate, is an increase in moss growth where the sea washes against the rocks of the Antarctic Peninsula. Ironically, unlike the rest of the world beyond its icy frontiers, the fringes of Antarctica are going green. ■

Beautiful bond

Topological materials have rekindled the romance between mathematics and physics.

The King left his wife in 1972, but it wasn't the break-up of Elvis and Priscilla Presley that bothered the eminent physicist Freeman Dyson at the time. He was more concerned about the difficulties he saw in an older and more fundamental relationship.

"The marriage between mathematics and physics, which was so enormously fruitful in past centuries, has recently ended in divorce," Dyson wrote. He may have been right about the split, and the two disciplines have each gone their own way since. But they have continued to be close. And, just occasionally, the romance reignites.

Right now, maths and physics are seeing each other again. They have bonded over a shared exploration of bizarre states of matter. In the past decade or so, principles and ideas from the mathematical exploration of a field called topology have found their way into the laboratories of condensed-matter physicists.

As we describe in a News Feature this week (page 272), physicists have been discovering states of matter that are topological. This means that the states have properties that change in discrete increments — such as increasing the number of holes in a surface — and not over a continuum, as would result from increasing the size of those holes.

Maths can sometimes seem hopelessly abstract, even to