as are the value of household and volunteer work, ecosystem services and community support. As economist and statistician Simon Kuznets, GDP's main architect, warned, a country's welfare cannot be inferred from GDP: "Goals for more growth should specify more growth of what and for what."

Mazzucato argues persuasively that GDP is a "hodge-podge" that "invites lobbying rather than reasoning about value". She notes that it "justifies excessive inequalities of income and wealth and turns value extraction into value creation". One alternative measure is the Genuine Progress Indicator (GPI), which attempts to separate environmental and social costs from benefits, to value household and volunteer work, and to adjust for inequality. For many countries, including the United States, China and the United Kingdom, there have been no net gains in GPI for several decades (I. Kubiszewski *et al. Ecol. Econ.* **93**, 57–68; 2013). You get what you measure, and misusing GDP as a policy goal is distorting decisions about real progress (R. Costanza *et al. Nature* **505**, 283–285; 2014).

Mazzucato deconstructs several other key trends. These include how the financial sector's "casino capitalism" mislabels market speculation as the creation of value rather than the mere extraction of value created elsewhere, and how the real value added by government and public goods and services have been ignored — to the detriment of us all. Ultimately, she notes, we need a more synthetic and integrative view: one that recognizes both how value is created and extracted in the current system, and how this needs to change. She concludes that value depends on vision: "If we cannot dream of a better future and try to make it happen, there is no real reason why we should care about value." The ability to value a healthy, sustainable planet, fairness, community and quality of life must be returned to the heart of economics.

Economics has been defined as the use of scarce resources to achieve desirable ends. In the Anthropocene epoch of human influence on the planet, we need to redefine those ends, and reevaluate which resources are truly scarce. Value should be viewed as contribution to the sustainable well-being of Earth and all its inhabitants. The United Nations Sustainable Development Goals are a huge step towards a broad global consensus on a desirable economy and society. As US baseball player Yogi Berra quipped: "If you don't know where you're going, you'll end up someplace else." Mazzucato's trenchant analysis is a compelling call to reinvent value as a key concept to help us achieve the world we all want. ■

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COSMOLOGY

The trouble with the Nobel prize

Ron Cowen weighs up Brian Keating's call to reform the most coveted award in physics.

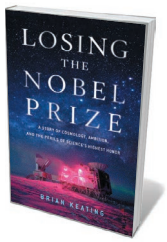
If cosmologist Brian Keating had his way, the scientific teams that made two of the most astounding discoveries in physics — the Higgs boson and gravitational waves — would never have won Nobel prizes.

It's not that Keating thinks the researchers undeserving. But the current rules and structure of the awards, he contends in *Losing the Nobel Prize*, foster ferocious and sometimes destructive competition for scarce research resources. He avers that the prizes are also biased against the work of female and younger scientists, and that they violate some of the very principles that Alfred Nobel, their founder, specified in his will more than a century ago.

Keating studies the infant Universe through subtle patterns in the cosmic microwave background (CMB) left over from the Big Bang. He is a deft writer, interweaving the science with personal musings on topics from his relationship with a father who abandoned him as a child to the passions that impel him to explore the unknown. Looming over all are his concerns about the Nobels.

These arose after his very public roller-coaster ride as part of a research team whose work briefly seemed a shoo-in for the physics prize. The team — a collaboration between institutions including the Harvard–Smithsonian Center for Astrophysics (CfA) in Cambridge, Massachusetts, and the University of California, San Diego (UCSD) — had built two radio telescopes at the South Pole to hunt for a signature in the CMB that could reveal how the early Universe had evolved. Keating conceived the first, BICEP1. The team then developed the more sensitive BICEP2, which observed the CMB from 2010 to 2012.

Rumours of a scientific coup began flying in March 2014, even before the CfA alerted the media of an imminent "major discovery". The press briefing on 17 March did not disappoint (I was there, covering the event for *Nature*'s news section). The team's four principal investigators, who included astronomer John Kovac, reported that they had detected a subtle twist in CMB polarization. They asserted that its source was almost certainly primordial gravitational waves, which would have been generated by inflation — a brief, faster-than-light ballooning of the infant Universe. That theoretical growth spurt had been a cornerstone of cosmology for some 35 years, but definitive proof had not been found.



Losing the Nobel Prize: A Story of Cosmology, Ambition, and the Perils of Science's Highest Honor
BRIAN KEATING
W. W. Norton (2018)

THE CURRENT RULES FOSTER **FEROCIOUS** AND SOMETIMES **DESTRUCTIVE COMPETITION** FOR SCARCE RESEARCH RESOURCES.

BICEP2's discovery reverberated across the media. At the briefing, accolades poured in. Keating, one of several team members not there, recounts his mixture of frustration and elation: although Kovac mentioned his work, it was not cited in the press release. Keating well knew that if a Nobel had been in the offing, he and most of the team would have been excluded, given the focus on principal investigators, and the rule that any prize can be shared by a maximum of three people.

The glory was, in any case, not to be. For months, Keating watched from the sidelines as the discovery literally turned to dust. All along, the BICEP2 team had worried that hydrocarbon soot and other cosmic particles could confound the results. (When light, including the CMB, reflects off non-spherical particles of galactic dust whose ▶

axes are aligned, the light is imprinted with the same curlicue polarization pattern expected from gravitational waves in the early Universe.) Yet the team decided to go ahead with the announcement, buoyed by data from a slide used for a 2013 talk by a scientist affiliated with BICEP2's chief competitor, the European Space Agency's Planck satellite.

The slide showed an unpublished dust map of unknown accuracy. Extrapolating from it, the BICEP2 team concluded that in the region of sky observed by its telescope, galactic dust would have little effect on the results. Keating writes that he objected to relying on such evidence for a high-stakes discovery, but was ultimately swayed. New data from the Planck satellite later revealed that dust had led the BICEP2 team to misread the results. Its vision, Keating feels, had been clouded not only by dust, but by 'Nobel lust' and the fear of being scooped.

Journalists embraced the BICEP2 announcement at first. It was an exhilarating story to report, and I have since debated whether its potential might have clouded my own vision. The dozen or so independent experts I contacted, who had read advance copies of a paper that the BICEP2 team would later post online, all commented positively on the work. But it's possible that for a few, confirmation bias played a part, because they were proponents of the inflation theory.

Keating suggests several remedies for Nobel fever. He argues that the physics prizes should be awarded only for serendipitous findings; an example is the evidence, discovered in 1998 by two teams of cosmologists, that the Universe was revving up its expansion instead of slowing down. If a team finds something it had set out to look for, it should not gain the Nobel, is his provocative view. Keating also asserts that Nobel prizes should be awarded to an entire team. He would eliminate the stipulation, added in 1974, that the prizes cannot be awarded posthumously. And he would allow more than one prize for the same research if a person was originally overlooked or ignored (which has, historically, often occurred to women, such as co-discoverer of radio pulsars Jocelyn Bell Burnell).

These changes, he argues, might motivate physicists to think outside the box in conducting research, and might discourage in-fighting. However, I doubt that reconfiguring the Nobels would accomplish what Keating hopes. As he himself notes, both the US and European processes for allocating funding and tenure encourage cut-throat competition. Modifying those ingrained systems would have much greater impact.

Keating notes that his own work has begun to embrace the spirit of cooperation. In 2016, the Simons Foundation, a private philanthropic foundation in New York City that supports research in maths and the basic sciences, gave the green light for him to spearhead a collaboration between his CMB team, based at UCSD, and one based at Princeton University in New Jersey. Together, they hope to dig from the dust a true signal of primordial gravitational waves in the CMB. Even if that pans out, the work would not be eligible for a Nobel under Keating's reforms; it would be science for science's sake. And maybe that's the point. ■

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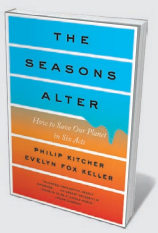
Highlights of this season's releases.



The Seasons Alter: How to Save Our Planet in Six Acts
Philip Kitcher and Evelyn Fox Keller LIVERIGHT *(2018)*
"Clearly, we need to talk." Philosophers of science Philip Kitcher and Evelyn Fox Keller call for constructive discourse on climate change in their unusual exploration of this urgent, highly politicized issue. While coherently explaining the science, they use Socratic dialogue to explore differing viewpoints. As they warn, considerate, productive conversation is essential if we're not to go down in history as "the people who argued while the world burned".