

The economics of progress

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On 9 February of this year, a British Airways Boeing 747-436 landed at London's Heathrow Airport 80 minutes ahead of schedule. Its flight from New York's JFK International Airport had taken just 4 hours and 56 minutes, thanks to a boost it received from Storm Ciara's powerful winds. No other subsonic airliner has crossed the Atlantic Ocean so quickly.

The previous fastest subsonic crossing, 5 hours and 1 minute, was made 41 years ago by a Vickers VC10 operated by BOAC. Granted, the plane took the shorter route from New York to Glasgow, Scotland. Still, the longevity of the VC10's record is remarkable, and it's due to the economics of air travel. Carrying more passengers in bigger planes is more profitable than flying a smaller number in faster planes.

The record for the fastest transatlantic crossing made by an ocean liner—an accolade called the Blue Riband—has lasted even longer. It was set in July 1952 by the SS *United States*, whose average speed was 34.51 knots (63.91 km/h, 39.71 mph). The voyage took 3 days, 12 hours, and 12 minutes.

A previous Blue Riband holder, the SS *Normandie*, entered service for Compagnie Générale Transatlantique in 1935. Passengers marveled at its grand Art Deco public rooms and sumptuous cabins. The ship's rival, Cunard's RMS *Queen Mary*, was just as luxurious, but because it had a higher fraction of public rooms and cabins devoted to the more numerous second- and third-class passengers, it made more money. The one true ocean liner sailing today, Cunard's RMS *Queen Mary 2*, made its maiden voyage from Southampton, UK, to Fort Lauderdale, Florida, in January 2004. Its maximum speed is 4.5 knots slower than that of the *United States*. Being faster was not worth the cost.

Economic considerations also play into the progress of science. Most basically, the total amount of money available constrains how much research gets done. When I visited physics departments in Hong Kong in 2008, I saw world-class experiments, all of which were being carried out in modestly sized facilities. The Hong Kong government supports curiosity-driven, peer-reviewed research, but not to the point that the territory's scientists can do big, expensive experiments. Individual countries balk at building a 30-meter-class optical telescope by themselves. They have to band together.

Most democracies dole out science funding using a combination of political priorities and community review. We like to think

that the best science is, within reason, funded. But that's not always the case. As Jason Callahan wrote in his December 2019 Commentary for *PHYSICS TODAY*, when it comes to NASA's space missions, sometimes a politician's personal preferences enter the fray.

A subtler influence is what's in fashion. Some fields explode with activity after a momentous discovery. In 2004 Konstantin Novoselov and Andre Geim devised a cheap and convenient way to make graphene, whose exotic properties had been predicted by theorists. Nine years later, after more than 3000 papers on graphene had appeared in the journals of the American Physical Society *alone*, the European Union launched Graphene Flagship, a €1 billion (\$1.1 billion) research initiative. I welcome the largesse, but I worry that it could be starving less fashionable fields.

Indeed, we should be especially concerned about fields that are currently unfashionable. Venerable classical electromagnetism spawned the vibrant field of negative refractive index materials. Dynamical astronomy was not a popular field when I was a grad student in the 1980s. Now it's revived, thanks to the discovery of other solar systems and the European Space Agency's astrometry missions, *Hipparcos* (1989–93) and *Gaia* (2013–). Few-body physics has also undergone a revival. Whoever kept funding those fields and—crucially—hiring researchers who practiced them during their dormancy deserves credit.

It's difficult, perhaps impossible, to predict what fields might be ripe for a revival, which means funders should continue to support curiosity-driven research regardless of fashion. And they should continue to support research that has yet to achieve its ultimate goal, despite decades of effort. I'm hopeful that physicists will eventually reconcile quantum mechanics and general relativity, formulate a microscopic theory of high- T_c superconductivity, and identify the nature of dark matter—to name just three. Continuing to fund those and other challenging quests will hasten their completion. **PT**



**Albert Einstein's
1950 speech,
"Physics, philosophy,
and scientific progress,"
was reproduced in
PHYSICS TODAY's
June 2005 issue.
Read it online at
www.physicstoday.org**