# THE ORIGINAL

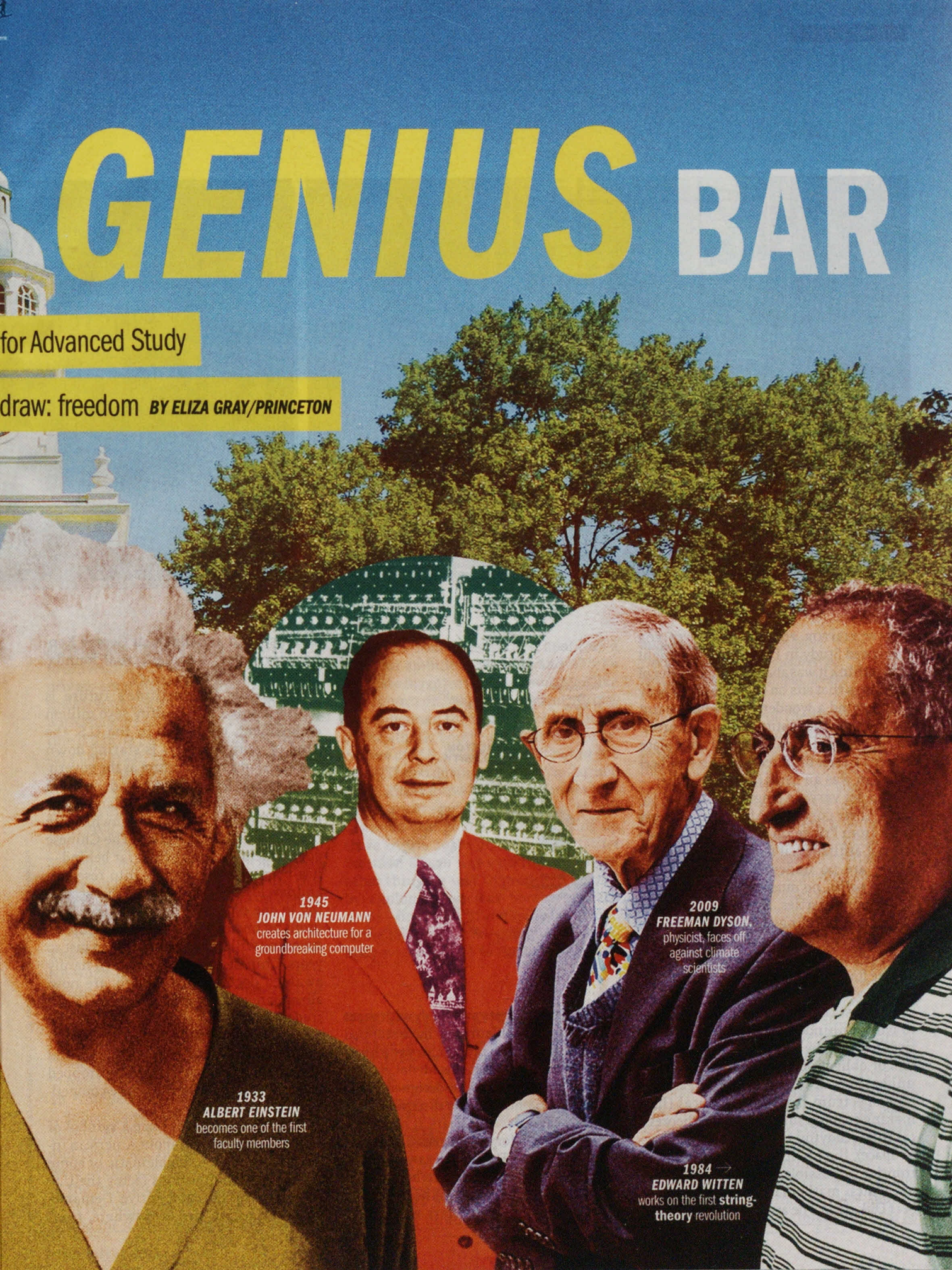
With money tight for scientific research, the Institute offers big brains a priceless

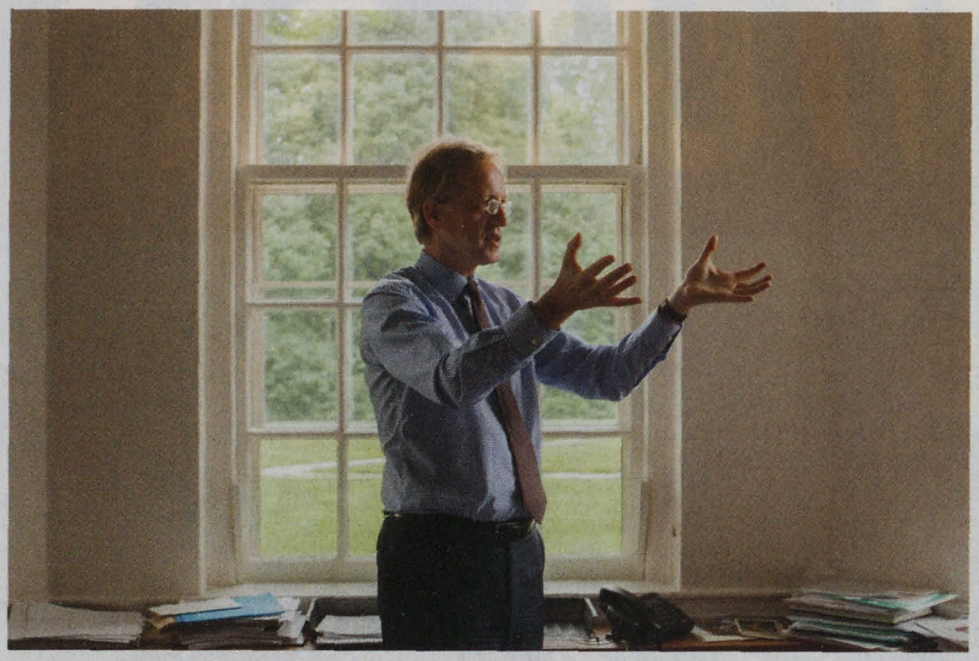

Photo-illustration by Sean McCabe for TIME

# GENIUS BAR

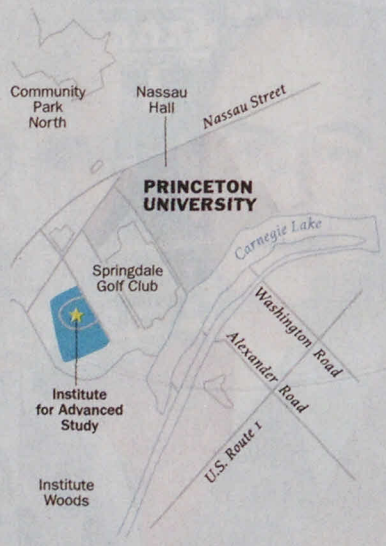
for Advanced Study

draw: freedom **BY ELIZA GRAY/PRINCETON**






A NEW VISITOR TO THE INSTITUTE FOR Advanced Study in Princeton, N.J., might at first think it was abandoned. A cluster of buildings that sits on the edge of a weedy field behind a wooden sign whose paint is chipping, the institute is not a university or a typical research center but a place where a couple hundred geniuses—Albert Einstein was an early faculty member—can go, for varying lengths of time, to indulge their curiosity. About a 20-minute walk from Princeton University (the two are not affiliated), it feels nothing like it. There are no undergraduates walking on the paths, no music blaring, no flyers advertising parties. Even the monastic apartment buildings where the scholars live seem not to emit any noise. It is as if every person on campus were holding in a sneeze for fear it might stop a transformative discovery.




The institute offers researchers a place to work unhindered by the pesky objectives required by traditional research centers or obligations to pimply students at universities. If research were measured on a spectrum from the practical (like making a laptop slimmer) to the theoretical (like studying the way matter moves in space), the institute is as "close to the frontier as possible," says its new director, Dutch mathematical physicist Robbert Dijkgraaf. The atmosphere, free from practical constraints and flush with great minds—33 Nobel laureates have stopped through along with more than two-thirds of the winners of the Fields Medal, math's top honor since 1936—was designed to create the ideal conditions for discovery. And in many cases over the years, it has. In its prolific early history, physicists Chen Ning Yang and Tsung-Dao Lee discovered that nature is not symmetrical, mathematician John von Neumann created the prototype on which future computers were built, and historian and diplomat George Kennan developed the intellectual foundations of realist foreign policy.

But while the institute's future is mostly assured by a healthy $650 million endowment, elsewhere in the U.S. the kind of work it fosters is staring down the barrel of a rough future as the government spends less than in past decades on research as a share of GDP. Many countries in Europe and Asia, meanwhile, are heading the other direction. The Chinese government—coming from far behind—has been pouring money into research and development at such a clip that according to one estimate from Battelle, a nonprofit technology-development group, its spending will surpass America's in just 10 years. Chinese universities, which hardly awarded doctorates years ago, are now, albeit barely, competing with the U.S. for students. The U.S. is already falling in some measures of innovation: in the decade from 2000 to 2010, the U.S. share of science and engineering academic citations dropped precipitously, putting it in close competition with the E.U.

If the institute was once a symbol of all that was powerful about American innovation, now it is emblematic of some of the toughest questions facing the U.S. in its fight to stay competitive. Demands for quick results are everywhere, from

PREVIOUS PAGES: GETTY IMAGES (7); REDUX (2); IAS; AP. THESE PAGES: JASON FULFORD FOR TIME


**Room to think** *Director Robbert Dijkgraaf; the institute's address in Princeton; books in a campus library*

corporations focused on quarterly reports to universities increasingly obsessed with private-enterprise partnerships that can spawn start-ups and burnish their image with students and donors. "I feel the institute is a little bit the canary in the mine," says Dijkgraaf, 53, who took his post last summer. "It is not clear a place like this can exist. Society is moving toward short-term thinking, toward direct applications. We are really swimming against the stream." In other words, pursuing questions for which the value of the answers isn't obvious may be a luxury that America can no longer afford—or at least appreciate the importance of.

### The "Intellectual Hotel"

FOUNDED IN 1930 BY ABRAHAM FLEXNER, an educational theorist, and siblings Louis Bamberger and Caroline Bamberger Fuld, department-store moguls who provided the initial endowment of $5 million, the institute was meant to counteract a trend in the U.S. toward applied science. Dubbed an "intellectual hotel" by one director, J. Robert Oppenheimer, it was a magnet during World War II for mathematicians and physicists, including Einstein, who were fleeing the Nazis. The early decades of the institute's history, just before and after the war, coincided with a formative period for science in the U.S., when MIT morphed from a technical school into a place for ambitious research and AT&T's Bell Labs invented the transistor. Men like von Neumann, who created game theory, Oppenheimer, the chain-smoking father of the atomic bomb, and Kennan, an architect of U.S. foreign policy toward the Soviet Union during the Cold War, turned the institute into a hub for academics who had a direct line to Washington. When historian George Dyson was growing up there in the 1950s and '60s—his father Freeman Dyson was working on, among other things, a way to propel spacecraft by exploding nuclear bombs beneath them—he recalls, "If you spilled your food at the table, you were going to hit somebody who could go to the telephone and call the President of the United States."

**'THE INSTITUTE IS A LITTLE BIT THE CANARY IN THE MINE ... SOCIETY IS MOVING TOWARD SHORT-TERM THINKING ... WE ARE REALLY SWIMMING AGAINST THE STREAM.'**

—ROBBERT DIJKGRAAF, DIRECTOR

Today the institute employs 28 permanent faculty members in schools of history, math, social science and natural sciences, along with roughly 200 visiting members who are selected for research fellowships of one to five years. Some 80% of the institute's operating expenses are funded by income from its endowment, which has been supplemented since the Bamberger days by donors including New York City Mayor Michael Bloomberg, a former trustee. (The campus now includes a Bloomberg Hall.) The rest of the operating budget comes from grants from private foundations and the government, mostly the National Science Foundation, the Department of Energy and NASA. As director, Dijkgraaf answers to a board of trustees that includes former Harvard dean Benedict Gross, Carlyle Group cofounder David Rubenstein and Google's Eric Schmidt. The chairman of the board is Charles Simonyi, the billionaire philanthropist and former Microsoft executive who became a space tourist in 2007.

The institute's financial security and reputation are as strong as ever—but its influence in Washington has fallen, as

has Washington's interest in science. Over the past 25 years, the U.S. government's spending on physical-science research has dropped by half. Sequestration—the $1.2 trillion in spending cuts in the discretionary and defense budgets over the next decade—has accelerated that, slicing budgets for agencies that support science research, like the National Science Foundation and the National Institutes of Health. The President's budget for next year calls for increased investment in science, including basic research, but his proposal has met opposition in Congress. As the U.S. retrenches, China is doing the opposite. Last year, the Chinese government significantly increased spending on basic research. On the basis of the most recent data from the National Science Foundation, China's combined public-private spending on R&D is rising at a clip of 20% each year. The U.S.'s is growing by 5%. Says technology policy expert Robert Atkinson, "We are simply making a choice to fund retirement homes instead of research laboratories."

When the government cuts research funding, basic-research projects get slammed. Industry funds only 22% of basic research to the federal government's 53%—the remainder comes from state and local governments, universities, colleges and nonprofits. And who can blame industry? Basic science can take decades to pay off—but it has also provided some of history's most important discoveries. The World Wide Web was invented as a better way for particle physicists to communicate, magnetic resonance imaging was discovered in the 1940s by physicists who were trying to understand if a nucleus had spin, and GPS resulted from the atomic clocks developed to test Einstein's theory of relativity. "I don't believe in these cases that you would have gotten where you wanted to go by thinking of the application first," says Marc Kastner, dean of MIT's school of science. "The [science] community will survive," he says, "but there will be less of these game-changing discoveries—at least in this country."

Though the famed Bell Labs fell victim to the breakup of the AT&T monopoly, there are some big U.S. business names playing in basic research, including Google and IBM, which has hired a number of institute alumni. In 1997, Microsoft turned to Jennifer Chayes, then a member at the institute, to spearhead new research groups. Chayes told Bill Gates he was crazy; the results wouldn't pay off for 100 years. Gates told Chayes, "Don't worry." Sixteen years later, Chayes has lured pure mathematicians, theoretical computer scientists and economists to labs in New York and Cambridge. "You don't tell them what they should work on. You don't tell them because it would be a crime," says Chayes. "You inspire them by letting them know about things going on in the real world, and then you look at output of the research, and you ask, Is there something here that can improve the products that we have or some IT that we should patent?"

### Celebrating Irrelevance

VLADIMIR VOEVODSKY, A 47-YEAR-OLD Russian mathematician and faculty member at the institute, is showing me how to teach a computer to do math. Padding across his office in black rubber Adidas sandals, past bookshelves stocked with science-fiction novels, he sits down at his computer next to a pile of scratch paper and opens a program that looks sort of like a word processor. As Voevodsky types each step of a proof, the computer checks his work and in the process learns how to perform the proof. The idea is to teach the computer higher-level reasoning that might eventually surpass humans'.

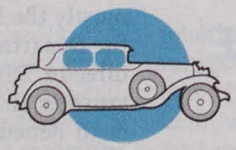
Voevodsky's abstract credentials are unimpeachable; his work in algebra won him a Fields Medal in 2002. But his project has a practical edge. If computers learn at this high level, they could teach math to humans and test new theories that are too difficult for humans to check. The potential for applications—and the decision to bring computer scientists to the institute for the first time since von Neumann built his computer in the 1940s—raised eyebrows. Voevodsky says the reception from fellow faculty was "cool but not cold" and that he wanted to do "math that is useful."

Not everyone at the institute shares that view. Nils Baas, 67, a visiting Norwegian mathematician, bristled when I asked if his efforts to classify cancer more precisely would lead to better treatments. "I'm studying this out of curiosity," he said. "Treatment is a nice benefit, but it shouldn't be the drive." Voevodsky disagrees: "This kind of attitude is a manifestation of one's own infantility."

It's also just the kind of thing that rankles many lawmakers when it comes to funding scientific research. "They relish in the fact that they are irrelevant," says Atkinson. "Scientists come up to Capitol Hill and say, 'We want money.' You say, 'Why?' and they say, 'You have no right to ask us that.'" Though quirky-sounding research has been a favorite target for some lawmakers going back to Senator William Proxmire's Golden Fleece Awards and beyond, the tension is particularly pronounced now, in the supercharged partisan atmosphere of budget debates.

One recent flare-up featured shrimp

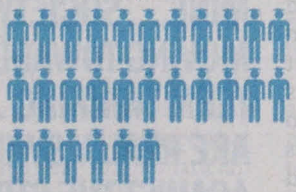
## THE INSTITUTE BY THE NUMBERS

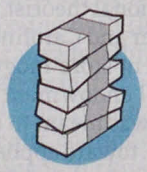


**1930**

The year the institute was **FOUNDED** by an educational theorist and department-store moguls

**28** Number of **PERMANENT FACULTY** at the institute at any given time





**$5,000,000**

Amount that Louis Bamberger and Caroline Bamberger Fuld **DONATED** to the institute in **1930** to **ENDOW IT**

running on treadmills. After 2008, a series of videos of shrimp running on tiny treadmills for a government-funded study went viral and became political shorthand for the feds' profligacy. The athletic crustaceans re-emerged in 2011 when Senator Tom Coburn included them in a report on wasteful spending by agencies like the National Science Foundation. (The shrimps' treadmill, which one of the scientists told NPR cost only $1,000, was part of a large project about ecosystems valuable to the shrimping industry, it turns out.) In March, in an amendment introduced by Coburn, the Senate's budget stipulated that political-science research should not be funded unless it has an impact on the country's economy or security, which may have a chilling effect on the National Science Foundation program to fund political-science research. Research defenders don't deny the existence of waste in science, but they caution that today's silly-sounding work can be tomorrow's breakthrough. An economic study into the matching of college roommates produced an algorithm that has made kidney-transplant systems more efficient, while a project to build a "family tree" of Web links by Stanford graduate students Larry Page and Sergey Brin turned into Google.

**'THERE WILL BE LESS OF THESE GAME-CHANGING DISCOVERIES—AT LEAST IN THIS COUNTRY.'**

—MARC KASTNER, DEAN OF MIT'S SCHOOL OF SCIENCE

### iPhones—in Space

THE INSTITUTE FEELS FAR AWAY FROM those fights. While Voevodsky types proofs into a computer in one room on campus, in another Patrick Geary, a medieval historian on the faculty, is using ancient DNA extracted from the teeth in skeletons lying in cemeteries in Italy and Hungary to map the migration of European peoples. Archaeology, the traditional tool for this, he says, is imprecise. "If someone tried to figure out who was at the institute in 1,000 years based on our cars, they might assume we were mostly German and Japanese." It's a long and expensive project that would have been difficult at a university. If it works—and there is no guarantee it will—Geary could find that ancestry across European countries is more similar than we realize, which has implications in Europe's pretty nasty contemporary debate about nationalism.

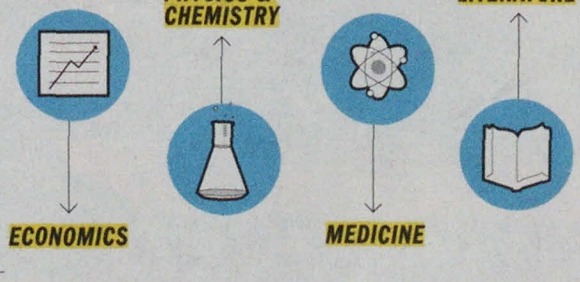
On a recent Friday morning at the institute, at the astrophysics department's morning coffee, everyone was having fun. A dozen physicists, dressed in hoodies or khakis and button-downs—most looking well under 40 and all but one male—were sitting around a conference table in front of a blackboard. James Lloyd, an astronomer from Cornell, had come to talk about his work developing small satellites. After he presented the meat of his project, the scientists lured him into more far-fetched discussions. "If I take my iPhone into a space station, can I connect to Verizon?" asked a young aptly named Indian-American scientist, Aristotle Socrates, as everyone laughed. "We could create a global, intergalactic network of iPhones," he said. Later Socrates explained that it was an inside joke, a reference to a time when Boaz Katz, an Israeli astrophysicist, proposed launching millions of iPhones into the galaxy as a way of communicating with other solar systems. When I asked Katz whether they had been joking or serious, he said it was a little bit of both. With astrophysics, he explained, you need a "speculative meter" to indicate what is "rigorous and what is still fantasy."

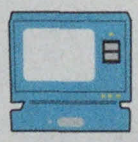
Playfulness is part of what the institute's director, Dijkgraaf, says he feels obligated to preserve. He's afraid that the appetite for funding research may be waning just when things are starting to get good. It's a pretty exciting time for science, particularly for cosmology and physics, where the discovery of the Higgs boson has brought us closer to understanding the origins of the universe. "Never in our history have we understood so much about where we are living, the planets, the universe. Never. It's the absolute high point, and then we turn off? I'm almost refusing to accept this," he tells me, his arms flailing Ichabod-like in the air.

For now, things at the institute hum along as they always have. In the time since I visited, Katz and his team of astrophysicists think they figured out why stars explode into a certain type of supernova—through a collision between two smaller stars called white dwarfs. It will be years before they convince the rest of the field that they are right. Where will it lead? It's hard to say. Recently, Katz's colleague investigated the possibility that their theory might explain Eta Carinae, a gorgeous star, which, if you Google it, you'll see looks a lot like an explosion from two colliding stars. The results show that their discovery probably does not explain that particular collision, but it may explain others. As we go over the possibilities, he says, "Use your imagination." ■

**33**

**NOBEL LAUREATES** have been faculty or visitors at the Institute for Advanced Study since its founding. Their fields:



**1945**

The year **VON NEUMANN** invented the architecture for his **REVOLUTIONARY COMPUTER**