

# Roger Penrose, Black Holes and the 2020 Nobel Prize in Physics



QUAMRUL HAIDER

THREE scientists have been awarded the 2020 Nobel Prize in Physics. They are the British mathematical physicist Roger Penrose, German astrophysicist Reinhard Genzel, and American astronomer

Andrea Ghez. Penrose, a professor at Oxford University, is recognised for his research on black holes carried out in the 1960s. According to the Royal Swedish Academy of Sciences, Penrose has been honoured “for the discovery that black hole formation is a robust prediction of [Albert Einstein’s] general theory of relativity.” Professors Genzel of Max Planck Institute and Ghez of the University of California in Los Angeles were awarded the prize “for the discovery of a supermassive compact object” in a region called Sagittarius A\*, located at the centre of our galaxy, The Milky Way.

The criteria for awarding Nobel Prize in Physics are defined in specific terms. Alfred Nobel’s will stipulates that the prize should be awarded “to the person who made the most important discovery or invention in the field of physics.” The crucial words in the will are “discovery” and “invention.” It is arguable whether developing a theory can be considered a discovery per se, but it is certainly not an invention in the sense that we normally associate an invention with. That is why the prize is seldom given to theoretical physicists, unless their theory is testable or verifiable.

When theorists won the prize by themselves, for example John Bardeen, Leon Cooper and Robert Schrieffer for their theory of superconductivity, it was for a

major theoretical formulation of an existing phenomenon, and thus can be considered as part of the “discovery” of that phenomenon. And theoretical physicists Peter Higgs and François Englert were awarded the Nobel Prize after the particle—Higgs Boson—predicted by their theory to complement the Standard Model of the Universe was experimentally detected.

While the awards to Genzel and Ghez are incontrovertible because they fit Nobel’s criteria quite nicely, Penrose is a rather unusual choice in that his award is not for a discovery. It is for using ingenious mathematical methods to reveal the implications of Einstein’s tour de force—the intimidatingly difficult-to-comprehend Theory of General Relativity.

However, long before Penrose’s prize-winning work on black holes, German physicist Karl Schwarzschild provided the proof of their existence just less than two months after Einstein published the general relativity equations in 1915. By solving the equations exactly, he identified a radius, known as the Schwarzschild radius that defines the horizon or boundary of a voracious gravitational sinkhole—a single point of zero volume and infinite density.

If a massive object could be compressed to fit within the Schwarzschild radius, which is three kilometres per solar mass, no known force could stop it from collapsing into the sinkhole. Today, we call this sinkhole a black hole. His work formed the basis for later studies of black holes, showing that the concentration of matter in a black hole is so great that no light could escape its staggering gravitational pulls, but rather follow a trajectory curving back towards the black hole, thereby making it unobservable.

Lest we forget, Einstein did not win the Nobel Prize for his revolutionary work on



From left to right: Roger Penrose, Reinhard Genzel, and Andrea Ghez.

PHOTO: COLLECTED

general relativity or special relativity. The Nobel Committee decided against them on grounds that the relativity theories were abstract and unproven, although observational proof of general relativity was provided in 1919 by the Cambridge astrophysicist Arthur Eddington. He famously measured the deflection of starlight passing near the Sun during a total solar eclipse. The deflection, known as gravitational lensing, resulted from warping of space, as predicted by general relativity. Instead, Einstein received the deferred 1921 prize in 1922 for his 1905 quantum interpretation of the photoelectric effect because it can be attributed to the discovery of the effect—emission of electrons from metal surfaces under certain illuminations—by the German physicist Heinrich Rudolph Hertz in 1887.

Despite his fame and impact on theoretical physics, Nobel Prize eluded the brilliant

physicist, mathematician and cosmologist Stephen Hawking, even though there is a general consensus that he has done more than anyone else since Einstein to deepen our knowledge about the cosmos. As noted by Penrose, a Nobel Prize for Hawking would have been “well-deserved” yet was possibly held back by the committee’s desire to honour observable, rather than theoretical scientific studies that are difficult, or almost impossible, to verify experimentally. Penrose’s work, albeit monumental and worthy of the Nobel Prize, cannot also be experimentally verified because of the very nature of the topics. So why relax requirements for work which are mostly theorems, some hypothesised in collaboration with Hawking?

Penrose is not the first scientist to predict the existence of black holes. The idea of black holes dates back even before Schwarzschild, to 1783, when an English cleric and amateur

scientist named John Michell and more than a decade later French mathematician Pierre-Simon Laplace used a thought experiment to explain that light would not leave the surface of a very massive star if the gravitation was sufficiently large. Michell called them “dark stars.”

In 1930, during a long voyage to London, 19-year-old Indian astrophysicist Subrahmanyan Chandrasekhar showed via calculations that when a massive star runs out of fuel, it would blow itself apart in a spectacularly violent explosion into a black hole. He received the Nobel Prize in 1983, not for his work on black holes, but for “studies of the physical processes of importance to the structure and evolution of the stars.”

For decades, the concept of black holes was no more than a mathematical aberration. They are well-nigh impossible to detect because light, one of our cosmic messengers, cannot escape from black holes. Hence, there is a total information blackout. How do we then infer about their existence? As the physics of black holes developed through the years, physicists realised that indirect routes were available. Consequently, our current understanding of black holes is built on inference drawn from data collected by X-ray, optical and radio telescopes.

Indeed, their existence was eventually confirmed in 1971 when astronomers detected a hint of radio wave emissions coming from an object in the constellation Cygnus. The emissions were later interpreted as the fingerprint of the black hole Cygnus X-1. Since then, numerous black holes, including supermassive ones, have been detected in our galaxy and elsewhere in the Universe.

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## ‘The India Way’ by S. Jaishankar: A must read



been a career diplomat for more than four decades, Jaishankar has had a ringside view of the evolution of India’s foreign policy as it moved and adapted to the various twists and turns on the global stage, both near and far, since the country’s independence in 1947. His representation of India as an ambassador in key missions like Beijing and Washington, DC—both of which form an integral part in India’s foreign policy—and his assignments in Moscow and Japan, among others, have served to enrich his first-hand knowledge and his experience as a diplomat. All this culminated with his appointment as India’s foreign secretary in 2015, an assignment that put him in the position of a kingpin in the execution of its foreign policy. This coincided with a period when regional and global geo-politics continued to shift at breakneck speed and, more often than not, followed an unpredictable pattern, while India’s relevance continued to gain currency in all these theatres and through all these stages. Now as its External Affairs Minister, Jaishankar has graduated from being a foreign policy practitioner to a maker of foreign policy. This ensures a continuity of his pivotal role in the domain of the management of India’s external relations. The book is pre-Galwan, and so the part of it that relates to India-China relations needs to be seen in that context.

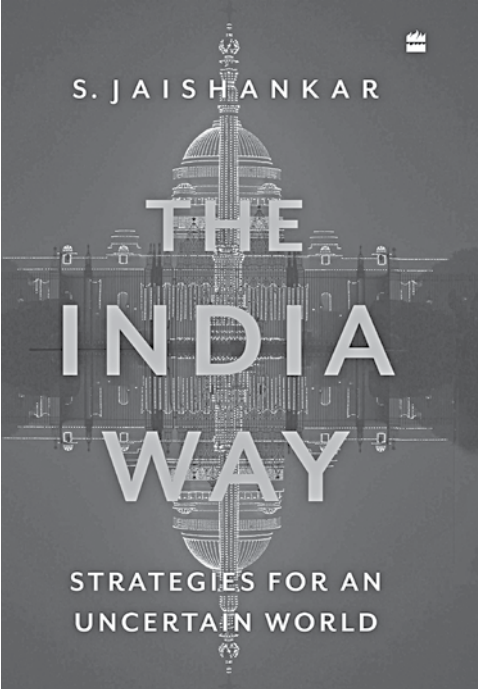
The richness of the book derives from the fact that the author has dwelled not so much on his own experiences as a diplomat, as many tend to do, but on India and the choices it made in the realm of foreign policy over a considerably long period of

time. Jaishankar has been most objective and candid in his assessment of where it did right and where it did not. As an example, he mentions, on more than one occasion, the positive impact that India’s role in Bangladesh’s Liberation War in 1971 had on India’s stature as a player not just in the immediate and peripheral region but also on the global stage, with an emphasis on the manner in which it was executed diplomatically and militarily. In the same breath, he describes India’s Sri Lanka exercise as a “misadventure”, one that failed to take into account the ground realities of local political and social sensitivities and the adverse military realities on the ground.

In the early part of the book, Jaishankar prescribes, from his vantage position, that the current time is one when India must engage America, manage China, cultivate Europe, reassure Russia, bring Japan into play, draw neighbours in, extend the neighbourhood and expand the traditional constituencies of support. He then goes on to elaborate on these goals in greater detail in the subsequent chapters.

Such a broad tapestry, needless to say, presents a major challenge for the policymakers, more so when some of the goals appear to be paradoxical, if not contradictory. However, the author strongly feels that if India were to continue to emerge as a consequential player in a multi-polar Asia, and in a shifting global order, it must be able to multi-task its foreign policy operations in a manner that will enable it to achieve its objectives and meet its own national interests in the short, mid and long terms. He says that such a bold approach may call for “plunging into the unknown”, which requires both judgement and courage. In a nuanced assessment of the past, he says that while the past may be an influence, it can no longer be a determinant of the future. In the same vein, he states that timidity cannot be passed off as a strategy nor indecision as wisdom.

Jaishankar expands on this by referring to a failed opportunity to settle the



“The India Way”, published by Harper Collins.

boundary and territorial issues with China in the early 1950s when the People’s Republic was globally more isolated, or for delaying India’s arrival on the nuclear platform until 1998 and not shortly after 1974. On the positive side, he describes the nuclear deal with the United States following long and hard bargaining as a major feather in India’s cap. On the latter, India demonstrated its determination to keep its options open while not being seen as a threat or a source of further nuclear proliferation. He also advocates that when it comes to matters of security, the country’s idealistic commitments, like the one to non-alignment, must not act as an impediment to India adopting a robust, proactive stance. He appropriately cites India’s position and its firmness to act, as it did in 1971 on the Bangladesh issue, as a case in point.

In chapter 4 of the book, titled “Dogmas

of Delhi”, Jaishankar spells out the evolution of India’s foreign policy making in six phases, starting with the time of independence in 1947 and reaching up to the present. This is basically a collage of its successes and failures. His description of failures includes the military defeat to China in 1962, and the inconclusive war with Pakistan in 1965. The triumphs include the victory in 1971 leading to the birth of an independent Bangladesh, the 1998 nuclear empowerment, and the 2002 nuclear deal with the US. This particular chapter, at least to me, represents the soul of the book, especially because of its prescriptive form. He suggests that a power that is serious about self-improvement should not shrink from undertaking an honest introspection regarding missed chances and shortcomings. Only through such an exercise, he believes, can the future courses of action be better planned and executed. He explains the seeming dichotomies in India’s multiple bilateral or multilateral arrangements as a willingness to look beyond dogmas and enter “the real world of convergences”.

As is to be expected, a complete chapter of the book talks of India’s long and most troublesome relationship with China, its neighbour to the north. He traces the history of the passage of this critical relationship, one whose ramifications do not remain limited to the two players only but spread deeply into the neighbourhood and far beyond, both on the land and in the sea. While covering the undulating nature and the difficult bilateral trajectory of this relationship in the current complicated global context, Jaishankar states that the challenge for India is to manage a more powerful neighbour while ensuring its own rise. The Galwan skirmishes in May this year, leading to military casualties on both sides for the first time in many decades, have thrown in a very different element into an already difficult equation. In the face of hardening nationalist sentiments on both sides following Galwan, policymakers may need to go back to the drawing board to face

the future.

In the book, Jaishankar describes the multifaceted nature of India’s relations with the United States and the challenges and opportunities therein. India’s difficult ties with Pakistan, both bilaterally and in the context of China’s place in it, find due mention.

The author argues strongly for a sustained and vibrant engagement with Japan by India that will augment the existing diplomatic ties with security arrangements. For an India that is moving forward in the Indo-Pacific region, this makes perfect sense. Importantly, the book balances well the importance of its relations with the bigger global players as much as it should with its immediate and smaller neighbours. He emphasises that an India growing in strength needs a friendly neighbourhood.

The book is aptly rounded up with a summary of the imponderables that the coronavirus has thrown up globally. Jaishankar argues that the pandemic that still shows no sign of letting up has made it abundantly imperative for all to find common ground on the very questions that are today sources of contention.

“The India Way” is a well-choreographed compilation of taking stock of past events and actions, placing them in the present context, and helping them shape the future course of India’s foreign policy. Given the richness of its contents, its objective form and candid expressions, it’s a must read as much for the current and future generations of India’s foreign policy practitioners as it is for the policymakers. Diplomatic and global political analysts outside the country will also find it a very useful book to study.

Dr. S. Jaishankar does not hesitate to admit that while India may be a rising power, it clearly has a long distance to go. It is this sense of pragmatic realism that makes the book a product of high quality scholarly work.

Shamsheer M Chowdhury, BB, is a former foreign secretary of Bangladesh.

QUOTABLE  
Quote

**RAY BRADBURY**  
(1920 - 2012)  
American author.

*We are cups, constantly  
and quietly being filled.  
The trick is, knowing  
how to tip ourselves  
over and let the  
beautiful stuff out.*

CROSSWORD BY THOMAS JOSEPH

ACROSS

1 Clumps of grass

6 Social blunder

11 Bay

12 Soothe

13 Dinero

14 Penniless

15 Radius

neighbor

17 Has debts

18 Grant of films

20 Ontario,

for one

22 Dull existence

23 Sicilian port

26 Stood

28 Noble gas

29 Tippling

accounts

31 Greedy desire

32 Spill the beans

33 Low card

34 Motor sound

36 Walked over

38 King or czar

40 Outdo

43 Cold house

44 Good judgment

45 Breakfast bread

46 Plus

DOWN

1 Director Burton

2 First numero

3 Thin flatbread

4 Tube, to Brits

5 Ollie's pal

6 Talker's gift

7 TV weatherman

8 Spots with beds

9 Bogus

10 Peepers

16 In the style of

18 Beach crawler

19 Mystique

21 "Woe is me!"

23 Ring

24 Lawn tunneler

25 Just

27 Sound systems

30 Diner sandwich

33 Musical sounds

34 Legal paper

35 Sci-fi award

37 Parks in civil-

rights history

39 Nonsense

41 Take advantage

of

42 Sulky state

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11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46

10-16

YESTERDAY'S ANSWERS

F A C E S C A R A B  
A L A N A L P A C A  
M E T S T A P P E D  
E X C U S E M E  
H R S P A P E R  
S L E E T S L A T E  
L O S T A D  
U S U R P F A C T S  
R E P E L A S H  
C O R O N A O S L O  
U N I T E S R U I N  
B E G E T S E P E E

BEEBLE BAILEY

BY MORT WALKER

WHAT'S THIS?

SOMEDAY WE MAY HAVE TO FIGHT IN EXTREME WILDERNESS CONDITIONS

I THOUGHT WE MIGHT NEED A CONSULTANT

GRIZZ ASSOC

BABY BLUES

BY KIRKMAN & SCOTT

I THINK SOMEONE MIGHT HAVE A CRASH ON THEIR TEACHER

REALLY? WHO?

THE ONE SPELLING "MRS. GAULPIN" WITH HIS PERS

OH BOY.

SIGH!