BANGLADESH'S ZAHID HASAN
Princeton's Physicist Extraordinaire

FAKHRUDDIN AHMED

PRINCETON University Physics Professor M. Zahid Hasan, born and brought up in Bangladesh, electrified the world of physics last month by discovering the elusive massless quasi particle, Weyl fermion, predicted 85 years earlier. By its ability to act as high mobility particle that can behave as matter and antimatter inside a crystal, the use of the particle can help advance electronics and computing by making these energy-efficient and faster.

Physicist and mathematician Hermann Weyl predicted the existence of Weyl fermions in 1929. In a recent paper published in *Nature Communications*, Professor Zahid Hasan and his team of international collaborators theorised the existence of Weyl fermions as quasi particles in a tantalum arsenide type of crystals. Through high precision experiments at Princeton University laboratories, they evaluated several crystal structures before finding the asymmetric crystal tantalum arsenide.

Cooling the crystal to near absolute zero in a two-storied scanning tunnelling spectromicroscope, they ascertained if the crystal matched the theoretical specifications for hosting a Weyl fermion. Those crystals that passed the test were taken to Lawrence Berkeley National Laboratory in California and subjected to high energy accelerator-based photon beams. Weyl fermions' existence was confirmed by studying the shape, size and direction of the photon beams after they had traversed the crystals.

The findings were published in *Science* on July 16. Negatively charged electrons drive modern electronics. Massless Weyl fermions can potentially provide more stable, efficient and speedier transport of particles than electrons once materials are further perfected for device fabrication. The Weyl fermions come in both varieties - right-handed and left-handed- meaning they spin in the same direction of motion, or its opposite. "The physics of the Weyl fermion are so strange, there could be many things that arise from this particle that we're just not capable of imagining now," says Professor Hasan.

Professor Hasan emphasised that unlike many other exotic particles which appear fleetingly in the aftermath of particle collisions, Weyl fermions, discovered inside the synthetic tantalum arsenide crystal, can be controlled for utilisation in devices.

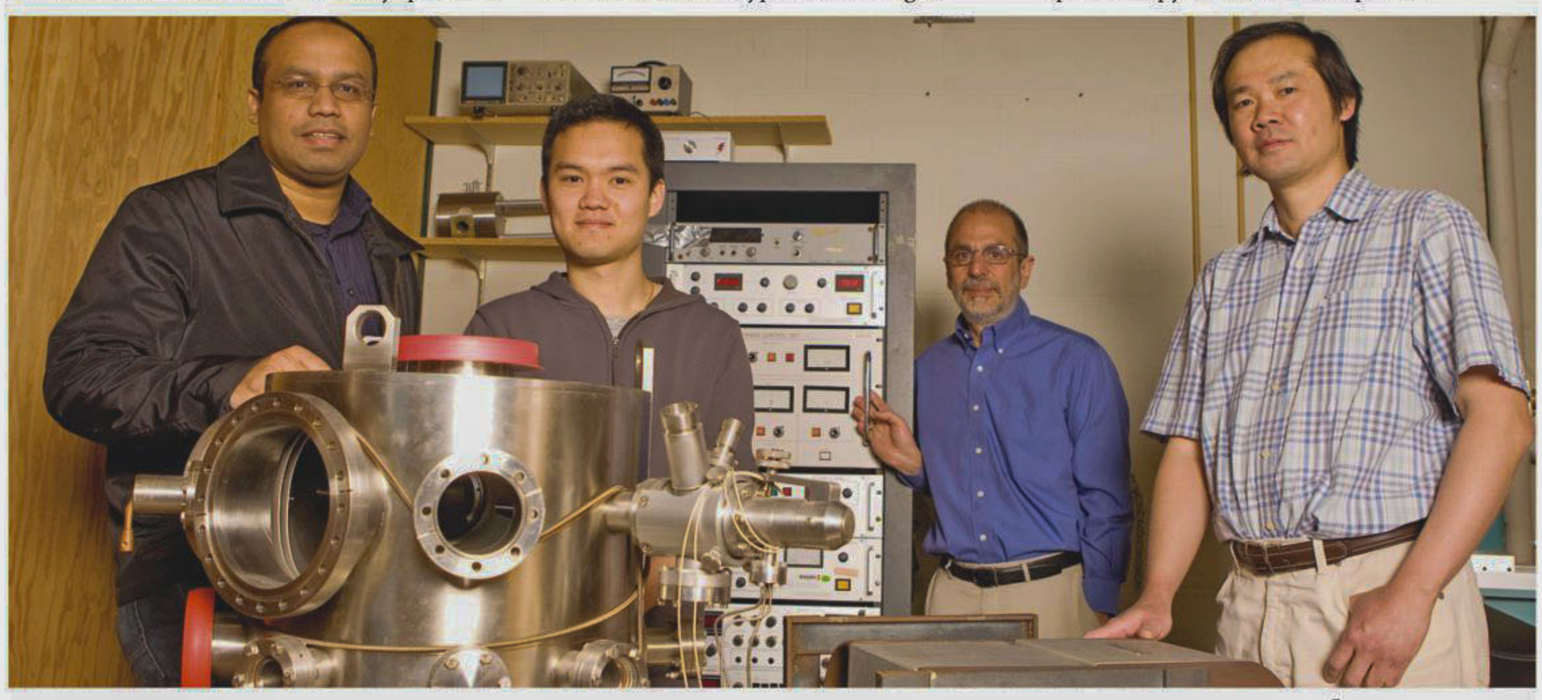
"For a physicist, the Weyl fermions are most notable for behaving like a composite of monopole and antimonopole-like particles when inside a crystal," Professor Hasan added. "This means that Weyl particles that have opposite magnetic-like charges can nonetheless move independently of one another with a high degree of mobility," the Professor elaborated.

While electrons are lost when they collide with an obstruction, Hasan et al found that Weyl fermions can be used to create massless electrons that move very quickly without backscattering, which hinders efficiency and generates heat in modern electronics. "Weyl electrons simply move through and around roadblocks giving them ultrahigh mobility," Professor Hasan explained.

Professor Zahid Hasan is the latest in the line of world famous physicists hailing from the subcontinent. Bangali mathematical physicist Satyendra Nath Bose (1894-1974), who spent 25 years at Dhaka University's Physics Department (1921-45), was the first. In 1924, Bose sent a paper to Albert Einstein arguing that the Maxwell-Boltzmann distribution did not apply to subatomic particles, and proposed a different statistic.

Einstein agreed, translated Bose's paper, "Planck's Law and Hypothesis of Light Quanta" into German, and published it in *Zeitschrift für Physik* with Bose as the sole author, launching "Bose-Einstein statistics." To honour Bose, Nobel Prize-winning physicist Paul Dirac named the particles obeying Bose-Einstein statistics "bosons" (such as, Higgs boson). Dirac also coined the term "fermions" (such as Weyl fermions) for the particles obeying Fermi-Dirac statistics, to honour Enrico Fermi. Fermions obey Pauli exclusion principle.

Bose inspired Pakistan's Professor Mohammad Abdus Salam (1926-96), a theoretical physicist, who shared the Nobel Prize in 1979 for his work on electroweak unification. The first Indian scientist to win the Nobel Prize was Chandrasekhara Venkata (CV) Raman (1888-1970) in 1930. Just as Hermann Weyl had predicted the fermions named after him and Professor Zahid Hasan discovered it, Adolf Smekal had theoretically predicted the inelastic scattering of photons in 1923, before Raman experimentally discovered it. These days, Raman spectroscopy is considered a part of Chemistry. CV Raman's nephew, astrophysicist Subrahmanyam Chandrasekhar (1910-1995), University of Chicago, also won the Nobel Prize in 1983.



Professor Zahid Hasan with other Princeton scientists who worked on the experiment in which the quantum Hall effect was seen in a material without the presence of an applied magnetic field. PHOTO: **BRIAN WILSON**

Mohammad Zahid Hasan (Taposh) is the eldest of the three children of Mr. Mohammad Rahman Ali and Mrs. Nadira Ali Talukdar. Zahid's mother encouraged him to study science. In 1986, at 16, Zahid published his first book on science, *Aesho Dhumketur Rajjae* (Come to the World of Comets: An Astrophysics Primer), unwittingly foreshadowing his own meteoric rise. Zahid stood second in the combined merit list of Dhaka Board, from Dhanmondi Government Boys School in the SSC examination of 1986, and first in HSC from Dhaka College in 1988.

After attending a few days of class at Dhaka University's Physics department, Zahid left for the University of Texas at Austin on a scholarship, to study physics. At Austin, Zahid came under the influence of (took classes from) Professor Steven Weinberg, who had shared the 1979 Nobel Prize with Professor Mohammad Abdus Salam.

Zahid completed his masters and doctorate at Stanford University. Not only did Zahid collaborate with many distinguished physicists, his own renown began spreading far and wide. In 2002, Princeton University invited him to present a seminar on his research, and offered him a faculty position afterwards. Zahid became a full professor in 2011.

If one were to list in this write up the innumerable awards this young physicist has won in America and abroad, that would exhaust the space available here. Suffice to say Professor Zahid Hasan is a most sought after speaker and delivers seminars worldwide to expound on the fields of research he excels in, including "topological insulators" which can potentially be the basis for a new kind of quantum information and computing.

It has been my privilege to know Zahid ever since he came to Princeton in 2002. I have never met a person so brilliant and famous, yet so self-effacing and humble. Zahid's wife Sarah is an equally brilliant MIT-educated engineer, who works for Microsoft. They have two adorable children: Arik Ibrahim Hasan (13) and Sarina Maryam Hasan (11).

Currently, Zahid is the toast of Princeton University's Physics Department, which boasts of 17 former and current Nobel Prize winners. Yet, the way Zahid carries himself, one would never know! Professor Zahid Hasan is the pride and inspiration of his community – Bangladeshis, Muslims and South Asians in America.

The writer is a Rhodes Scholar.

PRIMARY EDUCATION
Learners or Just Test-takers?

MANZOOR AHMED

THE primary education authorities – especially the Directorate of Primary Education (DPE) and the Ministry of Primary and Mass Education (MoPME) – must be busily preparing for the Primary Education Completion Examination (PECE) or *Shomaponi* to be held in November.

Over 3 million children completing grade 5 of primary school will sit for the nationwide public examination. Education experts, academics, researchers and informed citizens have questioned the value of this examination. They have in fact pointed out the harm it causes citing educational theory, research and international experience. Teaching-learning has been taken over by test-preparation, they argue.

The authorities have not been persuaded to reconsider their position ignoring all evidence and arguments. They have doggedly defended it, which reflects a problematic decision-making process in our education system.

Education Watch (EW) Report 2014, based on an empirical nationwide survey, to be released on August 19, looked at the pros and cons of PECE. It has brought out damning evidence about the problems arising from PECE.

The EW team led by Samir Ranjan Nath, and guided by a technical committee consisting of education experts, has followed the usual methodology of EW reports of collecting representative sampling of relevant data and surveying views of major stakeholders including students, teachers, parents and education personnel.

SOME KEY FINDINGS

The following are some key findings of EW 2014 study.

- *Exam-centric teaching-learning and rote memorisation has been given a boost by PECE.* Memorisation and drilling have become synonymous with studying; understanding of contents have very little or no space.
- *Dependency has increased on paid private tutoring.* Private tutoring has spread to all types of institutions and socio-economic groups both in urban and rural areas. EW estimated a total household expenditure of a thousand crore Taka for this purpose, close to total public expenditure for primary education.
- *Guidebooks have pushed out textbooks.* Guidebooks have become the principal instrument for studying to most students, school teachers and private tutors. The appeal of the guidebook is in its ready-made answers to likely exam questions, which are memorised and drilled without the trouble of reading textbooks and supplementary materials, learning the content and figuring out own answers.
- *Students are enticed to learn malpractice and unethical behaviour.* A large number of examinees, supported directly or indirectly by teachers and examination organisers, anxious to score high at any cost, engaged in malpractices and inappropriate behaviour in and outside examination halls.
- *Inequality has increased throughout the system.* Inequality in terms of school type, urban-rural dichotomy, gender, pupils' background and private expenditure has increased with the household spending and preparation for PECE.

FIVE CRITICAL CONCERNS

Five questions about PECE have been raised by the EW Study.

a) *Does it measure defined competencies of primary education completers?* Only a moderate relationship between competency-based test and PECE results (a correlation of 0.60, for those statistically inclined) indicates problems in this respect. The high pass rate in PECE and the low levels of competency acquired by fifth grade students in Bangla and math as assessed by National Student Assessment survey under DPE auspices is one kind of evidence among others. The latter shows that only about a quarter of students completing class five are achieving basic skills in Bangla reading and writing and simple mathematical calculations.

b) *Does it contribute to improving the teaching learning process and thus quality of education?* The effects of PECE have been to encourage drills and rote memorisation, neglect understanding and creativity, disregard basic content of the curriculum, and discourage thinking and reasoning.

c) *Does it support, complement and encourage formative evaluation in classroom and school as an essential element of good pedagogy?* Formative assessment is continuing day-to-day attention by teachers to ascertain if their students are learning what they are supposed to learn. In educational terms, this is more important than the summative assessment like PECE. PECE has taken away time and effort from formative evaluation and regular teaching learning.

d) *Does it contribute to quality with equity in the system?* Results so far show that the private kindergartens serving the more privileged have an advantage in terms of PECE performance. Household expenditure for private tutoring is worsening prevailing inequities.

e) *Is it consistent with creating a developmental and supportive environment for young children?* PECE, which replaced school-based annual class five examinations, with its grading system and high profile publicity of results, declares quite unfairly more than half of the young children falling between grades 1 to 3 incompetent non-achievers. This is the reason most countries have abandoned competitive and high profile public examination at an early age.

It is difficult to agree with the official position that PECE has been a major step in valid and reliable assessment of student learning and improvement of quality in primary education.

WAY FORWARD

EW report recommends general steps for improving quality of instruction and some specific measures for reforming student assessment. It argues for redesigning the *nature of the completion of examination, focusing on measurement of foundational skills in Bangla and math and changing the high stake character of the completion of examination.*

Intentional or incidental, the examination has become a source of anxiety and grief for students, parents, teachers and school authorities. The direction based on experience and research point towards making the national assessment primarily focused on foundational skills of language and math and a diagnostic of the system performance – schools, teaching-learning, subject wise issues and disparities in outcomes – rather than grading individual students.

A solution would be to have a category of **"pass with distinction"** for those scoring 80 percent and higher and all others awarded a **"pass."** Students' scores can still be recorded and used for research and analysis of the system. The completion examination should be re-designed based on experience of other countries as well as the National Student Assessment experience in Bangladesh.

Teachers must be supported, respected and empowered to do their job. Teachers should be at the centre of any education system along with students. The education system has to help teachers understand their duties, enable them to develop and apply their professional skills to guide and assist their students and take responsibility for what they do. Assessment has to create the space and the conditions for teachers to play their role in the classroom with their students.

Even a national assessment can be given a local face. At present, DPE with its limited human resource, conducts the largest public examination in Bangladesh as a wholly centralised operation. A basic competency-based test focusing on foundational skills can be less cumbersome to administer. Multiple versions of the question sets can be distributed randomly to the Upazila level just prior to the exam to protect test security.

Such a move would be consistent with the National Education Policy recommendation of Upazila-based examination at the grade five level and a national assessment after grade eight.

It is too late to do anything about the 2015 examination. But if better sense prevails, necessary actions can be taken early to redesign the examination for 2016. Children and the primary education system may be spared the perils of PECE.

The writer is Professor Emeritus, BRAC University and Vice-Chair of CAMPE.

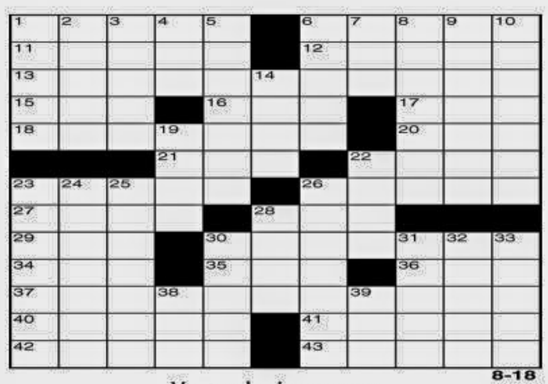
CROSSWORD BY THOMAS JOSEPH

ACROSS

1 . Sire
6. Make suitable
11. Quartz variety
12. Messing on TV
13. Utah national park
15. Snaky fish
16 .Huck's pal
17. Restful resort
18. Justice succeeded by Kagan
20. News-stand buy, for short
21. Fuming feeling
22. Cause of ruin
23. Big families
26. Raft pilot
27 ."Ratatouille" rat
28. Hit show letters'
29. Frozen over
30. Major league play, in slang
34. Saloon
35. Kanye's music
36. 'The Matrix" hero
37. Nationals' star outfielder
40. Clear
41. Wake
42. TV's Leary
43 Door sign

DOWN

1. Innocent ones
2. Wading bird
3. Singer Crystal
4 .Series-ending abbr.
5. Seesaws
6. Second US president
7. Lion's home
8. Very bad
9. Fuel gas
10. Colorful bird
14. Volcano shape
19. Like kudzu
22. Blockhead
23. Plagiarized
24. "Smiley's People" author
25. Oscar nominee for "Gone Baby Gone"
26. Get ready
28. Old Iranian title
30. Grove sight
31. Advice
32. Gaggle members
33. More tender
38. Long-running CBS drama
39. Friend of Harry and Hermione



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Yesterday's answer

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