viding a model with important functional implications.

## Climate changes

'Abrupt climate change at the end of the Last Glacial Period inferred from trapped air in polar ice'
J. P. Severingham and E. J. Brook
*Science*, 1999, **286**, 930

'16°C Rapid temperature variation in Central Greenland 70,000 years ago'
C. Lang, M. Levenberger, J. Schwander and S. Johnsen
*Science*, 1999, **286**, 934

Two papers in the 29 October 1999 issue of *Science* provide evidence for rapid changes of temperature, unconnected with current concerns on the effects of human activity. The clues are provided by analysing the isotopic composition ($^{15}N/^{14}N$ and $^{40}Ar/^{36}Ar$) of air bubbles trapped in ice cores.

## Selective tranquilisers

'Benzodiazepine actions mediated by specific $\gamma$-aminobutyric $acid_A$ receptor subtypes'
U. Rudolph, F. Crestani, D. Benka, I. Brunig, J. A. Benson, J.-M. Fritschy, J. R. Martin, H. Bluethmann and H. Möhler
*Nature*, 1999, **401**, 796

Pop a pill and relax, is an attitude that has become widespread. Sleeplessness, anxiety and unexplainable tensions are all treated widely, often without proper prescriptions, by consuming the drug Valium, a pre-eminent member of the benzodiazepine class of molecules. Valium and its analogs act on the $\gamma$-aminobutyric acid (GABA) receptors in the brain; a process rendered mechanistically complex by the multiplicity and heterogeneity of receptors. Using transgenic mice containing a point mutation (His 101 Arg) in the murine $\alpha$1-subunit gene, this study shows that mutant animals failed to exhibit the sedative, amnesic and partly, the anticonvulsant action of Valium. In contrast, the anxiolytic, myorelaxant, motor-impairing and ethanol potentiating effects are retained. Pharmacology has traditionally probed receptors with drugs and analogs. Now specific modification of receptors may permit selective dissection of pharmacological effects.

## Diffraction from a light-crystal

'Dynamical diffraction of atomic matter waves by crystals of light'
M. K. Oberthaler, R. Abfalterer, S. Bernet, C. Keller, J. Schmiedmayer and A. Zeilinger
*Phys. Rev.*, 1999, **A60**, 456

It is common knowledge that periodic structures like real crystals diffract waves be they light, X-rays, electrons or neutrons. What happens when particles are incident on a periodic structure made of standing waves of light? This paper deals with realization of 'perfect crystals of high purity' using light and that matter and waves can swap their roles satisfying a dynamical theory of diffraction; a beam of particles, namely that of argon atoms get diffracted from a crystal of light (made by a red laser beam) at the expected Bragg angle. There are many other novel aspects discussed in the paper.

## Interference of $C_{60}$ molecules

'Wave–particle duality of $C_{60}$ molecules'
Markus Arndt, Olaf Nairz, Julian vos-Andreae, Claudia Keller, Gerbrand vander Zouw and Anton Zeilinger
*Nature*, 1999, **401**, 680

Interference of de-Broglie waves associated with light particles like electrons, atoms, neutrons has been known for nearly 70 years. Of late atom interferometry has addressed itself to observe interferometry of matter waves of much larger objects, which has remained quite challenging. For lighter particles the associated de-Broglie wavelength is generally larger than the size of the particle itself; for heavier objects the associated wavelength is much shorter than the size of the particle. In this paper, the interference of $C_{60}$ particles using a material-absorbing nano-fabricated $SiN_x$ grating consisting of nominally 50 nm wide slits with a 100 nm period, is reported.

# OPINION

# The amoral scientists – The tragedy of Hiroshima

*M. V. N. Murthy, R. Shankar, Madan Rao, J. Samuel and A. Sitaram*

The life and times of the chemist, Fritz Haber, as recounted by S. Ramaseshan, in his article 'The amoral scientist – Notes on the life of Fritz Haber' (*Curr. Sci.*, 1999, **77**, 1110–1112), makes excellent reading. Haber became famous for synthesizing ammonia from nitrogen in the air. This led to the synthesis of nitrogen fertilizers, which helped grow more food to feed the world's population. Ironically, Haber can hardly be described as a humane person. Haber was the father of chemical warfare. He started the use of chlorine gas in warfare and was quite clear and logical about its 'advantages': it produces violent coughing, corrodes the eyes, nose, mouth, throat and lungs. Being heavier than air, it sinks deep into the trenches and forces soldiers out into the open, where they can be effectively killed! The translation of this cold clini-

cal logic into the reality of a battlefield is best described in the words of the First World War poet Wilfred Owen in his poem describing a chlorine gas attack. The poem is sarcastically titled 'Dulce et Decorum est pro Patria Mori' (sweet and proper it is to die for your country). This is an eyewitness account from a man at the receiving end of Haber's terrible new weapon. One of the men in his company fumbles in getting on his gas mask. In the poets words,

... But someone was still yelling out
and stumbling
And floundering like a man in fire or lime,
Dim through the misty panes and thick
green light,
As under a green sea I saw him drowning.

In all my dreams, before my helpless sight
He plunges at me, guttering, choking,
drowning.

If in some smothering dreams, you too
could pace
Behind the wagon that we flung him in,
And watch the white eyes writhing in
his face,
His hanging face, like a devil's sick of sin,
If you could hear, at every jolt, the blood
Come gargling from the froth-corrupted
lungs,...'

Haber's chemical warfare was, no doubt, initially effective. But it was only a matter of time before their enemies developed precisely the same weapon and turned the tide on the Germans. After all, one does not have to be an Einstein to develop chemical (or any other) weapons! With time, the allies too used Haber's methods and with the winds in their favour, used them more effectively. The trouble with unleashing a terrible new weapon, no matter how ingenious or effective it might seem at the time, is that the weapon acquires a life of its own and can be used in ways the inventor cannot foresee or control. Unlike many others (for example, Nobel) whose work led to destructive weapons, Haber felt no remorse at all. After the First World War he went on to develop the poison Zyklon B, which was later used by the SS to kill Jews (some of them Haber's relatives!) at Auschwitz. (See the letter by Amulya Reddy in *Current Science*, 1999, **77**, 1134–1136, for a description of Auschwitz and its technologically sophisticated methods of murder.) Finally, Ramaseshan makes the important point that while his synthesis of ammonia for fertilizers was beneficial to humankind, it would have been synthesized anyway by any number of talented chemists. It is hard to feel any admiration for Haber, whose work led to sophisticated ways of killing people as well as ways to feed them.

Indeed, recent history after the birth of the atomic age shows Haber's spirit is alive and well: the most glaring example of Haber's spiritual successors at work is the bombing of Hiroshima and Nagasaki. Once Germany surrendered on 8 May, 1945 the Manhattan Project lost much of its relevance. The scientists at whose urging the project was started in 1942 (L. Szilard and A. Einstein) felt so. But for many other scientists and their supporters in the establishment this was just the beginning of a power play in international politics. The focus shifted to the Pacific where the war was not yet over. A Target Committee consisting of scientists and administrators was appointed to select the likely targets. The minutes of its meeting held around the middle of May 1945 has now been declassified and can be found (along with many other documents pertaining to the decision) on the internet (URL: http://www.dannen.com/decision/).

The meeting was attended by, Farrell, C. Lauritsen, Seeman, Ramsey, Parsons, Dennison, Derry, von Neumann, Stearns, Wilson, Tolman, Penney, and Oppenheimer. In its agenda were the various technical points like the height of detonation that would maximize the impact, report on weather and operations, etc. The sections of the minutes pertaining to selection of the targets are most revealing and we reproduce them here.

*Status of targets*

**A.** Dr Stearns described the work he had done on target selection. He has surveyed possible targets possessing the following qualification: (1) they be important targets in a large urban area of more than three miles in diameter, (2) they be capable of being damaged effectively by a blast, and (3) they are unlikely to be attacked by next August. Dr Stearns had a list of five targets which the Air Force would be willing to reserve for our use unless unforeseen circumstances arise. These targets are:

(1) *Kyoto* – This target is an urban industrial area with a population of 1,000,000. It is the former capital of Japan and many people and industries are now being moved there as other areas are being destroyed. From the psychological point of view there is the advantage that Kyoto is an intellectual center for Japan and the people there are more apt to appreciate the significance of such a weapon as the gadget. (Classified as an AA Target)

(2) *Hiroshima* – This is an important army depot and port of embarkation in the middle of an urban industrial area. It is a good radar target and it is such a size that a large part of the city could be extensively damaged. There are adjacent hills which are likely to produce a focusing effect which would considerably increase the blast damage. Due to rivers it is not a good incendiary target. (Classified as an AA Target)

(3) *Yokohama* – This target is an important urban industrial area which has so far been untouched. Industrial activities include aircraft manufacture, machine tools, docks, electrical equipment and oil refineries. As the damage to Tokyo has increased, additional industries have moved to Yokohama. It has the disadvantage of the most important target areas being separated by a large body of water and of being in the heaviest anti-aircraft concentration in Japan. For us it has the advantage as an alternate target for use in case of bad weather of being rather far removed from the other targets considered. (Classified as an A Target)

(4) *Kokura arsenal* – This is one of the largest arsenals in Japan and is surrounded by urban industrial structures. The arsenal is important for light ordnance, anti-aircraft and beach head defence materials. The dimensions of the arsenal are 4100′ × 2000′. The dimensions are such that if the bomb were properly placed full advantage could be taken of the higher pressures immediately underneath the bomb for destroying the more solid structures and at the same time considerable blast damage could be done to more feeble structures further away. (Classified as an A Target)

(5) *Niigata* – This is a port of embarkation on the NW coast of Honshu. Its importance is increasing as other ports are damaged. Machine tool industries are located here and it is a potential center for industrial dispersion. It has oil refineries and storage. (Classified as a B Target)

(6) The possibility of bombing the Emperor's palace was discussed. It was agreed

that we should not recommend it but that any action for this bombing should come from authorities on military policy. It was agreed that we should obtain information from which we could determine the effectiveness of our weapon against this target.

**B.** It was the recommendation of those present at the meeting that the first four choices of targets for our weapon should be the following: (a) Kyoto, (b) Hiroshima, (c) Yokohama, (d) Kokura arsenal . . .

(7) *Psychological factors in target selection* – (A) It was agreed that psychological factors in the target selection were of great importance. Two aspects of this are (i) obtaining the greatest psychological effect against Japan, and (ii) making the initial use sufficiently spectacular for the importance of the weapon to be internationally recognized when publicity on it is released. (B) In this respect Kyoto has the advantage of the people being highly intelligent and hence better able to appreciate the significance of the weapon. Hiroshima has the advantage of being such a size and with possible focusing from nearby mountains a large fraction of the city may be destroyed. The Emperor's palace in Tokyo has a greater fame than any other target but is of least strategic value.

(8) *Use against 'Military' objectives* – (A) It was agreed that for the initial use of the weapon any small and strictly military objective should be located in a much larger area subject to blast damage in order to avoid undue risks of the weapon being lost due to bad placing of the bomb.

Shorn of the details, the committee wanted the bomb to be dropped on a large civilian population, perhaps having some military importance, but preferably populated by people of 'higher intellectual' ability to appreciate the extent of devastation. It was even better if there were natural hurdles like the hills of Hiroshima which would enhance the blast effects. Indeed, the targets were also listed based on the fact they were not targets of earlier bombings (presumably so that the effects of the new weapon could be demonstrated and studied more clearly). While effecting the surrender of Japan was of course one of the motivations, the most important aspect was the impact on the post-war world. As the minutes record, 'making the initial use sufficiently spectacular for the importance of the weapon to be internationally recognized when publicity on it is released.'

Not all the scientists involved in the Manhattan project displayed the cold (perhaps chilling!) Haberian logic of the Target Committee. While the Target Committee was deeply engrossed in identifying the victims, there were attempts by scientists at Oakridge, Chicago and Tennessee to prevent any misuse of the atom bomb. The Franck Committee, with James Franck as chairman and Leo Szilard as one of its many members, went into several aspects of these developments including the ethics of making and using these weapons of mass destruction. They foresaw accurately many developments that were to take place later:

> . . . the use of nuclear bombs for an early, unannounced attack against Japan inadvisable. If the United States would be the first to release this new means of indiscriminate destruction upon mankind, she would sacrifice public support throughout the world, precipitate the race of armaments, and prejudice the possibility of reaching an international agreement on the future control of such weapons.

This and several other petitions were referred back to a Scientific Panel for consideration. The scientific panel had as its members Compton, Lawrence, Fermi and Oppenheimer (Chairman).

Rejecting the concerns expressed by the Franck Report, the Scientific Panel went on to recommend the immediate use of nuclear weapons. This is what the Panel stated:

> 16 June 1945
>
> You have asked us to comment on the initial use of the new weapon. This use, in our opinion, should be such as to promote a satisfactory adjustment of our international relations. At the same time, we recognize our obligation to our nation to use the weapons to help save American lives in the Japanese war.
>
> (1) To accomplish these ends we recommend that before the weapons are used not only Britain, but also Russia, France, and China be advised that we have made considerable progress in our work on atomic weapons, that these may be ready to use during the present war, and that we would welcome suggestions as to how we can cooperate in making this development contribute to improved international relations.
>
> (2) The opinions of our scientific colleagues on the initial use of these weapons are not unanimous: they range from the proposal of a purely technical demonstration to that of the military application best designed to induce surrender. Those who advocate a purely technical demonstration would wish to outlaw the use of atomic weapons, and have feared that if we use the weapons now our position in future negotiations will be prejudiced. Others emphasize the opportunity of saving American lives by immediate military use, and believe that such use will improve the international prospects, in that they are more concerned with the prevention of war than with the elimination of this specific weapon. We find ourselves closer to these latter views; we can propose no technical demonstration likely to bring an end to the war; we see no acceptable alternative to direct military use.
>
> (3) With regard to these general aspects of the use of atomic energy, it is clear that we, as scientific men, have no proprietary rights. It is true that we are among the few citizens who have had an occasion to give thoughtful consideration to these problems during the past few years. We have, however, no claim to special competence in solving the political, social, and military problems which are presented by the advent of atomic power.

Note that the scientific panel sees 'no acceptable alternative to direct military use'. They however attempt to absolve themselves of any responsibility for its use by pleading that they have no special competence in solving the political, social, and military problems! This brings us back to the important point raised by Ramaseshan, the amorality of some scientists. The views quoted here of some scientists in the Manhattan Project refers to the period before the bombing of Hiroshima and Nagasaki. It is possible that the tragedy of Hiroshima and Nagasaki left a deep impression on them, since in a letter to the Secretary of War, Henry Stimson, immediately after the bombing of Hiroshima the members of the Sci-

entist Panel wrote '. . . We believe that the safety of this nation – as opposed to its ability to inflict damage on an enemy power – cannot be wholly or even primarily in its scientific or technical process. It can be based only on making future wars impossible.' (quoted in Philip Morrison, *Societal Issues – Scientific Viewpoint* (ed. Margaret A. Strom), AIP, 1987.) It is not clear from the letter whether they meant the control of these nuclear weapons or their elimination. The note written by Fermi in 1949 along with I. I. Rabi is however more forthright in recognizing the moral dimension of the challenge posed by the hydrogen bomb – 'It is clear that the use of such a weapon cannot be justified on any ethical ground which gives a human being a certain individuality and dignity even if he happens to be a resident of an enemy country.' (quoted in Sydney Drell, *Societal Issues – Scientific Viewpoint* (ed. Margaret A. Strom), AIP, 1987.)

Even more serious is the post-facto justification and the myths created about how Manhattan Project triggered the enormous scientific and technical developments in the West and the US in particular. One cannot but agree with the concluding statement made by Ramaseshan that any number of talented chemists would have conceived the synthesis of ammonia. After all fission was discovered before the Manhattan Project, unmotivated by its possible uses. Nuclear power and its peaceful applications would have been a reality with or without the Manhattan Project.

There has been no serious debate among the scientists of our country on the ethical and moral implications of a nuclear weaponization programme. The lesson to be learnt from Haber's involvement in chemical warfare and the role of some of the most distinguished scientists of this century in the Manhattan Project is that once a scientist leaves the cosy confines of his/her laboratory, (s)he *must* be guided by sound moral principles in developing applications of discoveries made in a clinical and detached manner in the solitude of a laboratory, for as Einstein said, the 'Man is, at one and the same time, a solitary being and a social being'!

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# From the archives


Vol. I] JULY 1932 [No. 1

## Retrenchment and Education

Whether in the present financial circumstances of the country, the Department of Education should have been brought under the general operation of the retrenchment policy of the Government of India, is a subject on which there is bound to be an honest difference of opinion. We can very well understand the force of the argument of those who advocate retrenchment, that Education is a branch of administrative service and therefore must share its fortunes along with the other departments. Moreover it will be pointed out that in other countries affected by similar financial blight, the curtailment of educational grants has been accepted as inevitable in the process of readjusting the attenuated revenues to the demands of the several departments of administration. . . .

We conceive that the best results could be obtained in probably the shortest time, if the Government and the leaders of the public would jointly prepare a ten-year Educational Plan based on a well-considered programme of University teaching and research work. The financial contribution for this work should be derived from Government grants and people's donations and endowments calculated on the basis of the interests and resources of the contributors. The administration of the funds and the direction and control of research departments and of the expansion of University Education on special lines, ought to be entrusted to a Board on which all the interests are duly represented. At the end of ten years the whole work may be reviewed. . . .