

increased proportion of sediments. The Bhadra and Tunga in Karnataka and the streams of Orissa are some examples, where ore deposits form the sediment's deposition. It would be worthwhile to get them removed for recycling and processing. It is also necessary to enact a ceiling on land use for mining in the river basins of the country for a period of another fifty years. Toxic wastes should not be released into the natural streams without treatment, as is being done by most of the industries. In the last fifty years, forest land exceeding 50 m ha, has been destroyed for unspecified reasons other than water storage works by the timber lobby. It must be noted (as documented) that in the last fifty years in developing all the irrigation projects, the country has not destroyed or utilized more than 2 m ha of prime forest land. There is considerable disinformation by vested interests. In order to take a holistic approach of riverbasin development and corresponding effective utilization of water, awareness among the public, orientation and channellization are important.

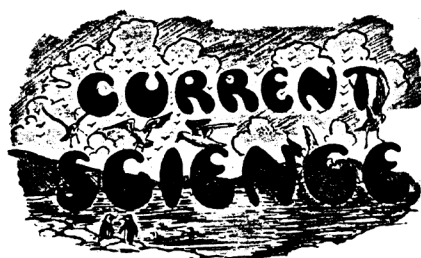
It must also be noted that the rural people are more conscious of the relevance and importance of conservation of water. This is well reflected in their readiness to participate at the micro-level in rural development. This has been well brought out by 'the statement of shared concern' in the Citizens Fifty Report signed by numerous scientists, environmentalists and social workers, and the article 'Towards a green millennium' (*The Hindu* 14 March 1999). Replication of the illustrated micro projects of socio-agro development is a far effective means of rural development, without any injurious impact on community as well as the land mass.

Recently, with drought relief as the basis, linking of Ganga-Cauvery has been projected. It is all the more necessary to examine each river basin development in its existing socio-geomorphological set-up. One has to establish whether such river basins, collectively two or three river basins in the same geomorphological set-up, cannot be examined for water

resource development to provide relief to drought-prone area of the region. The plan of action should be towards fulfilling the task of detailed study of such a scheme, duly processed and cleared by the Planning Commission.

Unfortunately, there is no lasting stable and enduring governance of the country. Leaders are pulling each other and indulging in fissiparous activities and digressing all their energies towards no enduring social objective of democratic society. This must stop. Only then will the virtues of development and utilizing nature's bounty be on firm ground. There is promise, but the turmoil must cease.

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X-rays, crystals and the infra-red spectrum

Sir C. V. Raman

The *Proceedings of the Indian Academy of Sciences* for October 1941 is devoted to a symposium of fifteen papers dealing with the interaction between X-rays and crystals which results in an excitation of the infra-red vibrations in the solid and a consequent reflection of the X-rays with change of frequency. This phenomenon was first described in an article in *Current Science* for April 1940 by the present writer and Dr P. Nilakantan, and was further reported on in the issue of *Current Science* for May 1941. The symposium now published is a comprehen-

sive account of the whole subject and shows that the new facts and ideas put forward in April 1940 were solidly based on reality. The theory given in broad outline in earlier publications is now fully developed and finds striking experimental confirmation in various directions.

The phenomena of the scattering of light in crystals show clearly that the interactions between matter and radiation which involve a change of frequency in the latter can only be successfully interpreted on the basis of quantum mechanics. That a similar situation also arises in regard to X-rays becomes evident when, it is recalled that the secondary X-radiation from a vibrating atom in a crystal appears, in part, with a change of frequency. Any coherent vibration of the atoms in a crystal with a specifiable frequency is therefore capable of giving rise to radiations of altered frequency which can interfere with each other and give rise to observable effects. The change of frequency involves an exchange of energy between the crystal and the electromagnetic field, and this can only occur in complete quanta or units of the particular vibration frequency. The interferences which arise may therefore be

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regarded as due to an inelastic collision of the X-ray photons with the crystal lattice. They appear as geometric reflections of the X-rays by the lattice planes of the crystal, analogous to, but quite distinct from, the reflections of the usual kind involving no change of frequency. . . .

An important result indicated by the quantum theory of X-ray reflection is that in particular cases, the classical reflections may vanish while the quantum reflections persist, or *vice versa*. In a remarkable paper appearing in the symposium, Mr Rama Pisharoty calculates the intensities of the (222) and (662) quantum reflections by diamond and shows that they are in agreement with the intensities as actually observed, thereby indicating that these so-called 'forbidden' reflections which should not appear on the classical theory are in reality quantum reflections. Another remarkable case of the kind is furnished by the ratio of the intensities of the (111) and (222) reflections by the lattice planes in rock-salt. The theoretical calculations by Dr Venkateswaran indicate, in striking agreement with observation, that this ratio is far smaller for the quantum reflections than for the classical reflections. . . .