100 years ago

A CORRESPONDENT of the *Daily News* in Lucerne sends to that paper an account of an electric mountain railway — the first of its kind — which has recently been opened to the public at the Burgenstock, near Lucerne. Hitherto it has been considered impossible to construct a funicular mountain railway with a curve; but the new line up the Burgenstock has achieved that feat under the superintendence of Mr. Abt, the Swiss electrical engineer. The rails describe one grand curve formed upon an angle of 112°, and the journey is made as steadily and smoothly as upon any of the straight funiculars previously constructed. A bed has been cut, for the most part out of the solid rock, in the mountain-side from the shore of the Lake of Lucerne to the height of the Burgenstock — 1330 feet above its level, and 2860 feet above the level of the sea. Through the opposition of the Swiss Government, each car is at the present time only allowed to run the half distance, and they insist upon the passengers changing, in order, as they say, to avoid collision or accident. A number of journeys were made up and down the mountain in company with an engineer, and the experience is sufficient to prove that the prohibition is altogether unnecessary. This interesting undertaking has been carried out at a cost of £25,000.

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carriers into the polyacetylene in these devices is quite different from the usual methods of chemical or electrochemical doping. Furthermore, the underlying physics is intrinsically different from that of conventional semiconductor devices with the injected charge stored in mid-gap rather than band states. Another notable point is that the good device performance is achieved with an essentially amorphous material. This is possible because in polyacetylene the fixed chain defects weaken π-electron interactions, giving a larger energy gap. Thus, in contrast to conventional semiconductors, structural defects do not produce localized states in the energy gap that would degrade device performance. □

1. Burroughes, J.H., Jones, C.A. & Friend, R.H. *Nature* **335**, 137–141 (1988).
2. Pople, J.A. & Walmsley, S.H. *Molec. Phys.* **5**, 15–20 (1962).
3. Su, W.P., Schrieffer, J.R. & Heeger, A.J. *Phys. Rev.* **B22**, 2099–2111 (1980).
4. Roth, S. *J. Phys., Paris* **44**, (C3) 69–76 (1983).
5. Heeger, A.J. in *Handbook of Conducting Polymers* (ed. Shothein, T.J.) 729–756 (Marcel Dekker, New York, 1986).
6. Thomann, H., Jin, H. & Baker, G.L. *Phys. Rev. Lett.* **59**, 509–512 (1987).
7. Friend, R.H., Schaffer, H.E., Heeger, A.J. & Bott, D.C. *J. Phys.* **C20**, 6013–6023 (1987).
8. Kanicki, J. in *Handbook of Conducting Polymers* (ed. Skotheim, T.J.) 543–659 (Marcel Dekker, New York, 1986).
9. Edward, J.H., Feast, J.W. & Bott, D.C. *Polymer* **25**, 395–398 (1984).
10. Bott, D.C., Brown, C.S., Winter, J.N. & Barker, J. *Polymer* **28**, 601–616 (1987).

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Radioastronomy

Methanol masers map new stars

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INTERSTELLAR methanol was first detected nearly two decades ago. Methanol radiation has been observed at over 100 different frequencies, including several masers (powerful radio emissions). But there was particular excitement over the discovery in 1987 of the 12-GHz (gigahertz) maser transition[1]. Its brightness is exceeded by only the water 22-GHz masers and it is widespread in star-forming regions throughout our Galaxy. On page 149 of this issue[2], R.P. Norris and co-workers present the first radio maps of seven methanol masers. There is an unaccustomed urgency about these and other observations of the 12-GHz maser. It lies in a frequency band where there is no official protection for radioastronomy and satellite broadcasts are already disrupting observations in some areas.

Cosmic masers are excited gas clouds whose spectral-line radiation is greatly boosted by the process of stimulated emission. They are valuable probes of star-forming regions because their high intensities make them readily detectable. Their powerful radio beams pass essentially unhindered through the screen of interstellar gas and dust which obscures the young stars at visible wavelengths.

Radio interferometers can map the maser clouds with great precision (see the recent News and Views article by Peter Scheuer[3]). The previously known hydroxyl (OH) and water masers have been extensively mapped using the Very Large Array (VLA) and MERLIN interferometers and very-long-baseline interferometry (VLBI) on angular scales from 1 arcsecond down to 1 milliarcsecond. The picture revealed is fascinating but incomplete. Now radio astronomers are hoping that the new methanol masers will help to fill some of the gaps.

The maps of seven source regions presented by Norris *et al.* in this issue[2] give the first picture of the spatial distribution of methanol masers. Each region consists of a cluster or string of point-like masers spread over some 10^{14} m — the size of the Solar System — surrounding a massive young star. The methanol clusters do not look exactly like the hydroxyl or water maser clusters, so that they will reveal something new about star-forming regions, although it is too early yet to predict just what their contribution will be. There is a broad similarity with the hydroxyl masers, both in terms of the size of the maser region and the range of radial velocities. But the lack of detailed agreement suggests that there are physical differences, at least on the small scale. Norris *et al.* remark on the tendency for the methanol masers to lie along lines, which could indicate an association with shock fronts, as has also been suggested for hydroxyl masers[4]. In a paper submitted to the *Astrophysical Journal* just 13 days after Norris *et al.* submitted theirs, Menten *et al.*[5] present the first VLBI maps of 12-GHz methanol masers which have higher resolution. Their measurements of the absolute positions confirm the close association between methanol and hydroxyl masers and compact regions of ionized hydrogen (H II).

With their smaller beam, Menten *et al.* can establish that individual methanol masers have apparent sizes of less than 3×10^{11} m and brightness temperatures exceeding 2×10^{10} K. This measure of the maser gain is important for elucidating maser physics. There are strong indications that far-infrared radiation from the dusty cocoon of the young star is an important factor. For example Kemball *et al.*[6] have found methanol masers in a survey of IRAS (Infrared Astronomical Satellite) far-infrared sources and they point out that sufficient far-infrared photons are available to excite the methanol masers in all cases. But other factors, perhaps chemical, must also be involved. As yet methanol masers have been found only in star-forming regions, not for example in cool circumstellar envelopes where similar infrared fields prevail[7]. Given the complexity of methanol's rotational and torsional spectrum it may be some time before the maser pump is fully understood.

The rapid progress which is being made in the study of the methanol 12-GHz masers is just as well. The 12-GHz frequency is marked out for satellite broadcasting. Although methanol masers are intrinsically very powerful, the signals which reach us stand no chance against man-made transmissions. This hazard was already apparent when the discovery of the 12-GHz maser was announced[1]. Now radio astronomers are working against the clock to learn the secrets of methanol masers before progress of another kind drowns their cosmic message in a sea of man-made radio waves. □

1. Batrla, W. *et al. Nature* **326**, 49–51 (1987).
2. Norris, R.P. *et al. Nature* **335**, 149–151 (1988).
3. Scheuer, P. *Nature* **334**, 107 (1988).
4. Elitzur, M. & de Jong, T. *Astr. Astrophys.* **67**, 323 (1978).
5. Menten, K.M. *et al. Astrophys. J.* (in the press).
6. Kemball, A.J., Gaylard, M.J. & Nicolson, G.D. *Astrophys. J.* (in the press).
7. Norris, R.P. *et al. Astrophys. J.* **321**, L159–L162 (1987).

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