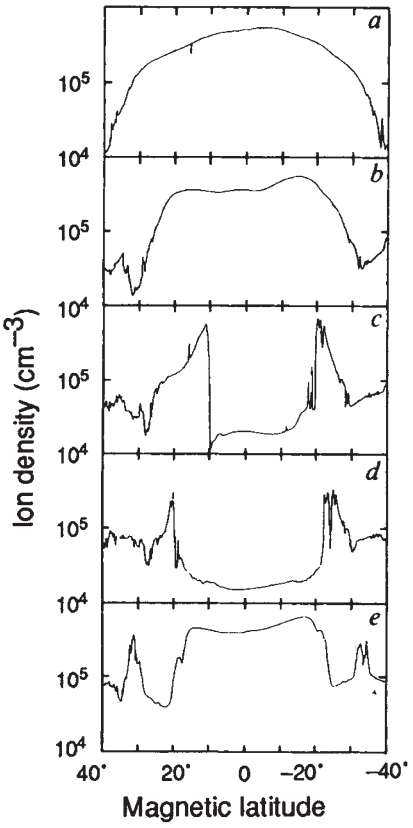
on Earth that exhibit an 11-year periodicity, the same as the well-known solar cycle (which is technically a 22-year cycle). These effects include auroral activity, magnetic storms and there are even examples of 11-year cycles in weather patterns[5]. The March 1989 activity marked the beginning of the maximum in solar cycle 22. Extraordinary solar activity was subsequently




Ion density as recorded by the DMSP F9 satellite at 21:20, 23:03, 00:50, 02:32 and 04:12 universal time on the night of 13–14 March 1989. Note the great depletion, or 'hole', in panels *c* and *d*. (From ref. 1.)

observed in September–October 1989[6] and most recently in March 1991. Gorney[7] provides a recent review of the effects of solar activity on the Earth, and summarizes several predictions about the current cycle, generally concluding that the maximum will be one of the largest on record. Furthermore, he suggests that periods of high solar activity, like that of March 1989, can be expected for a period of up to 4–5 years.

As discussed by Greenspan *et al.*[1], Batista *et al.*[2] and Huang and Cheng[3], ionospheric disturbances are caused by the heightened activity. The figure, taken from Greenspan *et al.*, shows how ion densities, measured during a series of equatorial passes by a military satellite, decreased dramatically at equatorial latitudes, corresponding to an equatorial 'hole' (panels *c*, *d*). The density variations at midlatitudes also show marked deviations from the normal situation. Greenspan *et al.* suggest that the penetration of magnetospheric electric fields and the generation of electric fields due to the disturbed motion of circulation patterns in the thermosphere cause large upward drifts of the equatorial plasma. This then causes a poleward drift, which leaves the equatorial ionosphere depleted. As a result of these ionospheric disturbances, the ionosphere's capability to transit or reflect radio waves is disrupted in a number of ways. The resulting communications disruptions affect military and civil operations.

Batista *et al.*[2] provide ground-based observations from Brazil which support the satellite observations used by Greenspan *et al.* These include measurements of the magnetic-field disturbances, variations in the critical frequency (maximum plasma density) of the ionosphere and the height of the critical frequency, and also the total electron content of the ionosphere. This paper discusses in some detail the role of electric fields in storm-related ionospheric disturbances. It is the penetration of the magnetospheric electric field and the disturbance-dynamo electric fields which are most important in driving the plasma drifts discussed here and with respect to the satellite observations.

Huang and Cheng[3] summarize a number of observations made in the Republic of China of the ionospheric disturbances as manifested in magnetic disturbances, total electron content and short-wave propagation effects. Among the most interesting of these are the observations of storm-related enhancements in the nightside total electron content followed by an unusually large decrease. Subsequently, wave-like oscillations were observed simultaneously at three different stations, suggesting "that the whole ionosphere [was] moving up and down during this disturbed period".

Of course, the ionosphere is only one part of the terrestrial system that can respond to solar activity. With such extremes of activity occurring during the current solar cycle, we can look forward to further reports of remarkable reactions in the magnetic field, plasma and neutral gas environment of the Earth. □

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DAEDALUS

# Cash on the rail

**WITH the collapse of the socialist dream, state industries are everywhere being privatized. Britain may even privatize its railway system. Anyone could then run a train from anywhere to anywhere else whenever they think it might pay, just like a bus or a truck. A separate authority would maintain the track and charge the trains rent. But how could such a chaotic network be signalled and kept safe? Daedalus has an answer.**

**He points out that two parallel steel rails form a transmission line, an open waveguide along which high-frequency radiation propagates like a sort of guided radar. At any discontinuity, the impedance mismatch reflects a certain proportion of the radiation. By launching a rail-guided signal to front and rear, a train could detect any other train on its track. This cunning rail radar would follow the track round any curve, and could even thread its way through the open point-switches of a complex junction, so as to search only the track that the train will occupy. Trains on other tracks will not interfere.**

**Radar-guided trains will be able to run safely at unprecedented densities to no central timetable. Each will know the speed and distance of its neighbours at all times. Switches set the wrong way, and obstructions on the line (a detached wagon, say, or a heroine tied across the rails by a moustachioed villain) will also show up clearly. Small track irregularities like level crossings will return weak permanent echoes; these will be mapped throughout the system to serve as navigation markers and 'road signs'.**

**When a conflict arises — as at a junction, crossover or section of single line — rival trains will negotiate their order of precedence by coded radar pulses. On sound capitalist grounds, Daedalus advocates a direct competitive auction. The switch-point will accept electronic 'bids' from the trains, and will open for the highest bidder. A shrewd train operator would probably give each train a budget (set perhaps by its number of passengers and the fares they have paid) to spend on track rental and setting the points along its route.**

**Thus the market will be served. Expensive trains full of rich businessmen will bulldoze their way through the system at high speed; cheap outfits carrying pensioners and students will dodder haltingly between them, or make long circuitous detours along empty loops of low-rent track; the track authority will learn how much profit accrues from each specific switch and section of track, so as to extend or abandon it as demand indicates. A fully cost-effective railway will result.** DAVID JONES