we find particle b moving in the retarded and attenuated field of particle a, and particle a moving in the full advanced and attenuated field of particle b. The use of the full advanced field rather than half the advanced tends to double the radiation reaction. The attenuation tends to cut it down—as it turns out—exactly in half.

The reason for the last point is that the response field from a layer of optical thickness $d\tau$ turns out to be proportional to $e^{-\tau}d\tau$ (ref. 2). The factor $e^{-\tau}$ is due to the attenuation of the field of a at b. When the reaction is also attenuated, an extra factor $e^{-\tau}$ is required, and the contribution becomes proportional to $e^{-2\tau}d\tau$. In the final result for the response field, the inclusion of attenuation has the effect of replacing $\int_0^\infty e^{-\tau}d\tau = 1$ by $\int_0^\infty e^{-2\tau}d\tau = \frac{1}{2}$.

Whether the effects of doubling the response field and of attenuating it cancel also outside the classical limit should be made clear.

AMNON KATZ
EZUZ ORNAN
MOSHE SCHWARTZ

Department of Physics,
Weizmann Institute,
Rehovoth, Israel.

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Microbarograph Observation of Acoustic Gravity Waves

MAY I comment on the recent letter in *Nature* by Murty and Curry[1] on microbarographic observation of acoustic gravity waves.

Events such as these authors describe are rather commonplace in Victoria, Australia, and one such occurrence has been recorded[2] at some length, while Pothecary[3] has noted an English case. Although it would be rash to claim that the processes responsible for exciting gravity waves in the atmosphere are fully understood, it is recognized here that pronounced and sustained pressure oscillations, of amplitude of the order of a millibar, are almost invariably associated with a shallow layer (1–2 km) of cold air, underlying much warmer air. This commonly occurs when a shallow but intense cold front moves north or north-eastward over Melbourne and becomes almost stationary. In most cases it is also possible to find evidence of precipitation, which may be associated with thunder, originating in the warmer air and penetrating the inversion, somewhere within, say, a hundred miles. The conclusion has been drawn that excitation by precipitation, or its concomitant downdraughts, of gravity waves on a marked low level inversion is responsible for the observed oscillations of surface pressure. Ramm and Warren[4] have given a quantitative treatment of the processes involved.

It is suggested that your correspondents should pay some attention to the vertical and horizontal density and wind distribution at the time of the phenomenon they describe.

R. H. CLARKE

CSIRO,
Division of Meteorological Physics,
Aspendale, Victoria 3195,
Australia.

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Concentration Wave Propagation in Two-dimensional Liquid-phase Self-oscillating System

OSCILLATING chemical reactions are interesting, not only in themselves but as models of a number of important biological processes[1–5]. Oscillating reactions have been described in which cerium (or manganese) ions catalyse the oxidation of analogues of malonic acid by bromate[6–8]. Oscillations in the concentrations of oxidized and reduced forms of the catalyst cause oscillations in the solution colour, while stirring leads to forced synchronization of oscillations throughout the whole volume. In the absence of stirring, periodic propagation of concentration waves occurs in certain conditions, and such a phenomenon in a one-dimensional system (a long tube) has been described[9,10]. Our work deals with patterns in a thin layer of solution (two-dimensional system).

Fe (1,10-phenanthroline)$_3$ is a convenient indicator for observation of spatial effects in our system. Ferroin and Fe (2,2′-dipyridyl)$_3$ could also be used, not only as indicators but also as catalysts, and it seems that a number of variable valence ions with one-electron transition and standard potential between 0·9 and 1·6 V may be used as catalysts in the system. In the present work, the system bromate, bromomalonic acid (BMA), ferroin was used. BMA was prepared by bromination of malonic acid by bromate–bromide mixture in acidic aqueous solution.

$$3\ CH_2(COOH)_2 + 2\ HBr + HBrO_3 = 3\ CHBr(COOH)_2 + 3\ H_2O$$

Similar results are obtained with BMA prepared by the method described by Conrade[11]. The reaction was performed at room temperature (about 20° C) in Petri dishes about 100 mm in diameter, with a solution layer about 2 mm deep.

Fig. 1 shows a series of sixteen photographs taken at one-minute intervals. In the first photograph, the catalyst is completely reduced, and subsequent photographs show it starting to be oxidized at particular points (leading centres), from which circular waves of oxidation are propagated. The fourth photograph shows oxidation taking place in areas not reached by these waves. The time when these transitions take place is determined by the oscillation period (T_o) of the main part of the space, which is equal to the system oscillation period in the case of forced synchronization by stirring. The next photographs show waves coming from leading centres (with $T < T_o$) oxidizing all the space step by step. When the waves coming from different leading centres collide, mutual annihilation takes place, with the point of collision, situated on a straight line between two leading centres, gradually moving towards the leading centre with the longer period. When a wave from a high-frequency leading centre reaches a low-frequency centre, the latter disappears, and, in the ideal case, a single leading centre with the highest frequency eventually synchronizes the whole space. In most experiments, however, some fronts break at the end of the process and space disorganization takes place (photographs 12–16).

Qualitatively distinctive patterns, for example, radial symmetric and small-cell patterns, are observed at other initial reactant concentrations. Those shown in Fig. 1 resemble Liesegang rings (LR), but it should be emphasized that the phenomenon described differs from LR in two significant features. First, in this case, there are progressive concentration waves while the sediment rings in the LR phenomenon are motionless. Second, LR-pattern is a fixed imprint of a reaction which has proceeded, but in our case the space structure is supported at the expense of redox reaction energy.

We consider here the simplest model of wave propagation in the system. In a one-dimensional system (a thin tube with length L, filled by solution), see Fig. 2, let all

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