On the other hand, we do not exclude the possibility that the phenomenon of 'detachment' is connected with the propagation along the lines of force of the magnetic field of a perturbation which would have its origin in the chromosphere.

It seems difficult from these results to reconcile this description of the expansion phenomenon of the outer solar corona with the hypothesis, accepted up till now, of quasi-stationarity at least in the ranges considered here, which are of the order of 10^5 km.

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Possibility of Determining Intergalactic Gas Density by Radio Observations of Flares of Remote Sources

DETERMINATION of the mean gas concentration in intergalactic space (N_{mg}) is an important problem which is still far from being solved. One may hope finally to determine the value of N_{mg} in different indirect ways (see, for example, ref. 1). At the same time there is a possibility of finding N_{mg} directly by measuring the radio signal retardation time $\tau(\nu)=t(\nu)-t(\infty)$ for a frequency ν, where $t(\infty)$ is the time of the arrival of a signal of a rather high frequency. In a completely ionized gas the refractive index $n=1-(e^2N/2\pi m\nu^2)$, the group velocity $u=cn$ and

$$\tau(\nu)=L/u-L/c=e^2N_{mg}L/2\pi mc\nu^2 = 1.34\times10^{-3}\ (N_{mg}L/\nu^2)\ \text{s}$$

where L is the distance to the signal source assuming $(1-n)\ll1$; the accuracy of the expressions used is clear (for example, from ref. 2). For our Galaxy, at not very small galactic latitudes, $\int N_g dl \equiv N_g L_g \sim (10^{20}$ to $10^{21})$ cm^{-2}. Therefore at $N_{mg}\sim10^{-5}$ cm^{-3} the product $N_{mg}L > N_g L_g$ if $L>10^{25}$ to 10^{26} cm. Thus, for extragalactic sources at more than 3 to 30 Mpc signal retardation in intergalactic space at $N\gtrsim10^{-5}$ is greater than in the Galaxy and could be measured (I note, as an example, that at $N\sim10^{-5}$, $\nu\sim3\times10^7$ Hz and $L\sim10^{25}$, the time $\tau\sim100$ s). To apply this method, which is widely used in the case of pulsars[3], there must, however, exist rapidly varying and powerful extragalactic radio emission sources; these have not yet been found.

I wish to draw attention to the possible appearance of suitable signals produced in the flares of supernovae or some other sources. I have in mind not entirely hypothetical considerations, which have already been widely discussed, but events connected with the cosmic γ-ray flashes recently discovered[4,5]. (N. S. Kardashov mentioned (personal communication) that the possibility of observing radio emission correlated with the appearance of 'optical' supernovae in other galaxies has already been discussed. But, both by the conditions of usual optical observations and by the very nature of the γ bursts observed, they do not correlate with optical supernovae (see also ref. 4) but do correlate with the radio bursts discussed here. Nevertheless, supernovae or unusual supernovae may be the sources of the γ bursts under discussion.) These flashes (with characteristic duration of the order of 0.1 to 10 s) are possibly caused by supernovae flares (at the initial stage of their evolution) at 1 to 10 Mpc (in the near future such events will be evidently observable also up to distances of 100 Mpc (ref. 5)). If such an explanation[4-6] is correct, then in a flare an energy $W\sim10^{47}$ to 10^{48} erg is transferred to γ rays and at least this energy is likely to be contained in the upper envelope of the star expanding at velocity $v\sim c$. In the course of further expansion this envelope must radiate mainly longer waves and particularly radio emission. The most effective processes are probably magnetobremsstrahlung (some magnetic field is certainly present inside the envelope) and different collective (plasma) mechanisms of radio emission.

It is hardly possible to estimate reliably the power or the total energy of radio emission. I do not see, however, any reason to deny the possibility of an energy output in a radio band of, say, $W_r\sim10^{-6}\ W\sim10^{41}$ to 10^{42} erg. For a distance $L\sim30$ Mpc this corresponds to the density $S=W_r/4\pi L^2\sim10^{-12}$ to 10^{-11} erg cm^{-2} or for a band $\Delta\nu\sim10^9$ it corresponds to the spectral density 10^{-21} to 10^{-20} erg cm^{-2} Hz^{-1}. These figures are, of course, arbitrary but help us to realise that in the region 30 to 300 MHz, particularly interesting for measurement of $\tau(\nu)$, the radio emission flux may be sufficient for detection. It seems reasonable to use several points of observation (see refs 7 and 8) and, of course, with correlation of radio measurements with γ measurements on satellites. The possibility is not excluded that it would be possible to register γ bursts even on the Earth's surface by observing some perturbations in the upper atmosphere induced by these bursts (primarily, I have in mind optical flashes arising at a considerable part of the Earth). Radio flashes should evidently retard by comparison with γ flashes (both on account of the influence of plasma during propagation and on account of the generation conditions), and radio signals of lower carrier frequency (according to the conditions of propagation and probably also to those of generation) should retard by comparison with signals of higher carrier frequency. If radio signals seem to be polarised, measurement of the polarisation parameters at different frequencies will yield additional information and first of all the mean value of $N(H)$ along the line of sight. (Here H is the projection of the magnetic field at the direction of observation.) Since the connection of the observed γ events with supernova flares is not yet proved, I note that the appearance of radio flashes is also probable for some other possible sources and will help to clarify their nature (for example, if these sources are galactic, that is, they are some flaring stars, the retardation $\tau(\nu)$ may prove insignificant).

Although the appearance of the type of sufficiently powerful radio signals discussed cannot be guaranteed, the corresponding observations seem fully justified.

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