so that the global hyperbolicity requirement and the b-boundary condition were obeyed[7,8].

Many authors (for example, ref. 9) have discussed the connection between Time's Arrow and black holes. The general consensus seems to be that one obtains a preferred direction of time only in those universes for which the initial conditions allow more black holes than white holes. If this connection between entropy increase and black holes is correct, then it is possible to use the new concept of black hole to define the direction of time geometrically—no reference to the behaviour of matter is made.

Definition: let (M,g) be a stably causal spacetime. The future time direction of (M,g) will be the direction of time for which the volume (in the metric g) of the region generated by all non-cosmological trapped surfaces is greatest.

This definition assumes, of course, that the volume occupied by the black holes is finite at least in one time direction. This is clearly true in Wheeler universes which begin and end in strong curvature singularities, for in this case the total volume of spacetime is finite. The relationship between the above geometrical time direction and the directions of time as defined by other, non-gravitational, physical processes will be discussed elsewhere.

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Detection of H_2O emission from galaxy NGC253

THE 6_{16}–5_{23} transition of water vapour at 22.235 GHz was observed for the first time in an external galaxy by Churchwell *et al.*[1] in M33 with the 100-m Effelsberg radio telescope in late 1976, after some previous unsuccessful searches[2,3]. We report here the second detection of H_2O emission from an external galaxy, NGC253, a large edge-on spiral galaxy situated at 3.4 Mpc (ref. 4), about five times farther away than M33. Previous observations of other molecules pointed NGC253 as a good candidate for H_2O emission: OH was detected by Weliachew[5] and confirmed by other workers[6,7]; CO was detected by Rickard *et al.*[8] and by Soloman and Zafra[9], and H_2CO was detected by Gardner and Whiteoak[10]. The time schedule of the 13.7-m Itapetinga radio telescope during 1977 May permitted a very long integration to be performed on this object, which is observable more than seven hours a day at elevation angles greater than 30°. The observations were made with a double sideband balanced mixer receiver of about 1,000 K system temperature and a 46 channel, 100 kHz resolution filter bank. Beam switching at a frequency of about 100 Hz was used, the main beam and then the 9′ reference beam being pointed at the nucleus of NGC253 for alternate intervals of 1 min. The sign of the recorded signal was changed every minute by the data acquisition computer, so that possible zero-level offsets of the channels were eliminated. One-hour integrations were made with the filter bank centred alternatively at three different frequencies in order to obtain greater velocity coverage, until a total on-source integration time of 21 h was completed at each frequency band. The data analysis program corrected the antenna temperatures for atmospheric attenuation as a function of zenith angle $\exp(-\tau \sec z)$ and then investigated the distribution of the results of the one-hour observations for each channel, giving the standard error of the mean and rejecting data more than 3 σ different from average values; the channels were subsequently averaged two by two, simulating a 200 kHz resolution system.

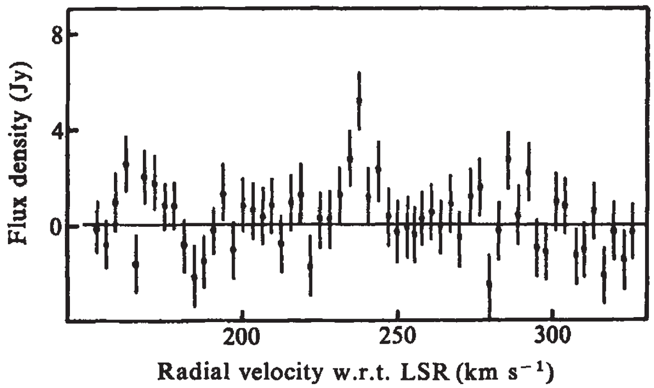

Fig. 1 The H_2O (6_{16}–5_{23}) spectrum of NGC253. The error bars are equal to twice the standard error of the mean obtained for each channel. The continuum flux of the nucleus of NGC253 has already been removed from the spectrum obtained from observations.

The H_2O spectrum of NGC253 is presented in Fig. 1, with error bars representing twice the standard error of the mean. An emission feature of 5.2 ± 1.2 Jy appears at $v = 233$ km s^{-1}, this is possibly associated with the same emitting region which produces the 1667 MHz OH emission observed by Gardner and Whiteoak at 239 km s^{-1} (246 km s^{-1} heliocentric) as such small velocity differences between OH and H_2O peaks are common in the sources of our galaxy, while the total velocity range due to rotation in NGC253 is larger than 200 km s^{-1}. We have no precise information on the position of the H_2O source since the 4′ beam is an important fraction of the 23′×5′ galaxy. The intrinsic power of the H_2O emission at 233 km s^{-1} is about three times greater than that of W49, the strongest H_2O source of our galaxy, during its maxima. The H_2O emission is, however, not so anomalous as the OH emission, as Gardner and Whiteoak estimated for the OH emission at 239 km s^{-1} an output power about two orders of magnitude greater than that of the most powerful Class I OH sources.

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