extension or contraction depending on the direction. Because of the orientation of the tunnel wall an extension actually represented a load bearing in the north-to-east or south-to-west directions, whereas a contraction represented loads in the north-west or south-east quadrants. A transducer was used to convert the rotation of the weight into a variable voltage suitable for chart recording. The problem of friction in the transducer and in the coupling of the transducer to the weight was one of the shortcomings of the simple instrument. A more serious problem was posed by the friction of the pivot linking the weight to the invar wire, although the effects of temperature and pressure in the wire proved less serious, because they turned out to be small by comparison with the effects of tides except at low frequencies.

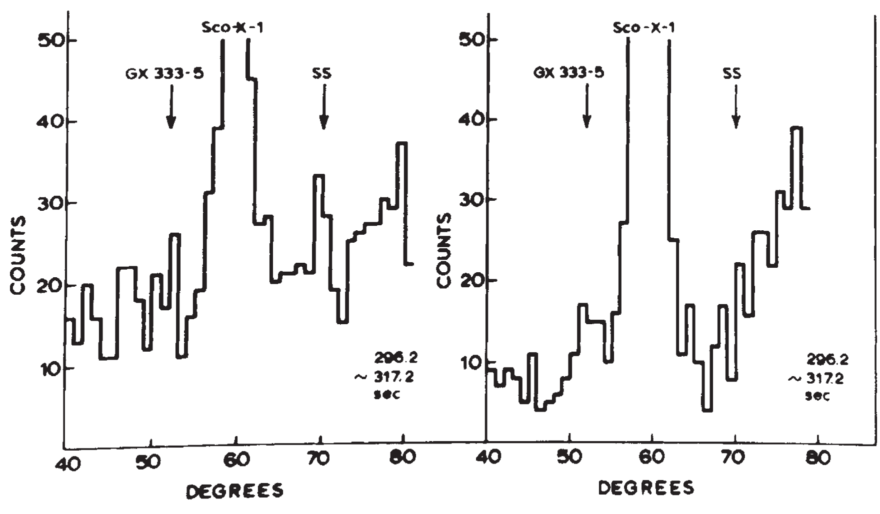
In spite of the problems, the recorded strain variations were of sufficient quality to warrant digitizing and spectral analysis. The chief interest of Bilham *et al.* was in the amplitudes of the various Earth tides and the degree to which the different components could be resolved, although they were also interested in studying the phase relationships between Earth tides as observed and calculated. To the latter end, therefore, it was necessary to determine Fourier components of the theoretical strain tide produced by the known motions of the Sun and Moon in a spherically symmetrical Earth having a distribution of elastic constants and density the same as that of the real Earth. This theoretical strain was calculated using the instantaneous tidal potential given by the positions of the Sun and Moon and the Love numbers calculated previously by Longman (*Geophys. J.*, **11**, 133 ; 1966). This allowed Bilham and his colleagues to generate a theoretical strain series over the same period as that over which a real strain was observed. Power spectra for both the observed and theoretical strain series were then determined, and all spectra were smoothed using a five-term Gaussian filter applied to the amplitude spectra.

The results showed that the smallest tides resolved (J and OO in G. H. Darwin's notation—*Scientific Papers*, **1**, 1 ; 1907) had strain amplitudes of $5 \times 10^{-10}$ and that the frequency resolution was considerably better than Bilham and his colleagues had expected. The comparison between the observed and theoretical tides revealed the most striking difference in the properties of the diurnal and semidiurnal tides. The observed diurnal tides were roughly in phase with the theoretical tides, but had an amplitude lower by a factor of about three. The observed semidiurnal tides, on the other hand, agreed with the theoretical tides in amplitude but were about 180° out of phase. Such a difference in phase and amplitude could arise if the regional strain field were to be distorted by local inhomogeneities, although King (*Bull. Roy. Soc. New Zealand*, **9**, 239 ; 1971) concluded, on the basis of geological and rock mechanical evidence, that this should not happen at a site like Queensbury. Differences between observed and theoretical strains might also be observed if the fluid or solid Earth had some natural period of the order of 24 h or 12 h—but there are no such periods. Bilham and his colleagues are thus forced to the conclusion that the strain tides at Queensbury are strongly influenced by oceanic tidal loading.

This general conclusion is further supported by more detailed analysis. In simple terms, if the observed, theoretical and ocean load-induced strain signals are represented by functions of frequency—*H*, *G* and *L*, respectively—then *L* may be regarded as the difference between *H* and *G*, both of which are known. It is then possible to calculate the ratio of *L* and *G* ($=R$) which is clearly zero if there is no oceanic tidal loading at all. In fact, for semidiurnal tides, *R* ranges from 1.47 to 1.91 for the tidal peaks N, $M_2$, $S_2$ and $K_2$ (Darwin notation), thus clearly showing the dominance of the oceanic loading strains (*L*) over those produced by direct gravitational effects (*G*). For diurnal tides, *R* lies between 0.41 and 0.43, showing the oceanic loading effects to be smaller but far from zero. Some years ago, however, Cartwright (*Phil. Trans. Roy. Soc.*, **A263**, 1 ; 1968) analysed sea surface spectra for six tidal stations around the British Isles and also found that *R* is usually less than unity for diurnal tides.

The next step will clearly be to see if the implied oceanic tidal loading effects at Queensbury agree in detail with those predicted from real oceanic tides. So far this has not been done, but it is likely to be complicated because Queensbury will presumably be affected by tidal loading in both the North Sea and the Irish Sea and, to a lesser extent, in the North Atlantic. It is already clear, however, that strainmeters placed away from the coast can be used to investigate the regional behaviour of tides. And, as Bilham *et al.* point out, this could be of some social benefit, for inland strain stations could perhaps be used to detect tidal surges in the North Sea before they cause flooding.

# Soft X-ray Source towards Galactic Centre




A ROCKET experiment flown on May 26, 1971, has led to the discovery of a discrete source of soft X-ray emission in a direction close to that of the galactic centre. In next Monday's *Nature Physical Science* (January 15) Bleeker and colleagues present spectra from several scans of the source and a best position error box. The source, designated SS, lies close to λSco, a bright spectroscopic binary of spectral type B1 V ; if SS is at the distance suggested for λSco by observations from OAO-2, then its luminosity in the band 0.37 to 1.9 keV is $2 \times 10^{33}$ erg $s^{-1}$.

It is interesting that SS does not appear with any comparable brightness at hard X-ray frequencies. In the figure, the left-hand histogram is for a scan at 0.37 to 1.9 keV, and SS can be picked out readily ; on the right, the same scan at 1.9 to 6.5 keV, SS is completely absent, indicating that the source has a very soft spectrum.