noise level on the charts. The power spectra of the amplitudes measured; pulses which could not be positively identified were assigned a value equal to twice the rms fluctuations from PSR 1919+21; power spectra computed from three additional sequences of pulses failed to confirm the reality of the peaks a, b and c, which should therefore be ignored. However, the peaks a' and b' with frequencies of 0.185 Hz and 0.370 Hz respectively appeared on all four estimates of the power spectrum and are probably significant.

The peak a' is a manifestation of the tendency already noted by Conklin et al., for an enhancement of every fourth pulse from PSR 1919+21. The effect has been interpreted by Drake and Craft as supporting their conclusion that there are two unrelated periods, one of the well-known duration of ~1.337 s and the other of ~15.5 ms. According to their hypothesis, the longer period modulation (class 1 pulses) provides a 'window' which allows the more basic shorter period pulses (class 2 pulses) to escape in the direction of the Earth; they predict from the ratio of the two periods that an enhancement of the pulse amplitude should occur once every 4.395 class 1 pulses, corresponding to a peak in the power spectrum at 0.1701 Hz. The position of the predicted peak is indicated in Figure 5 by the arrow marked 'D & C'.

It is apparent that the predicted frequency of the peak does not agree with that of a'. If Drake and Craft have correctly interpreted their data, the discrepancy can be resolved only by postulating that the period of the class 2 pulses had changed significantly between 1968 May 24 and 1968 August 26, these being the dates of the two sets of observations. If this interpretation of peak a' is correct, the period of the class 2 pulses on 1968 August 26 was 7.70% longer than on 1968 May 24.

Further determinations of the power spectra of the amplitude fluctuations from these and other pulsars, preferably from much longer sequences of pulses, may be expected to provide some important evidence bearing on the origin of the pulses.

The author wishes to acknowledge the assistance of Mr C.S. Higgins in the observations and Messrs E.R. Hill and P. Mulhall for computer programming. Thanks are due to Mr G. Trent for constructing the 100 kHz bandwidth filters and to the staff at Culgoora for their willing assistance.

A Comparison of Pulse Shapes of Pulsars at Different Frequencies

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Observations at a number of frequencies indicate that for at least two pulsars the average pulse shape has a slow but quite definite frequency dependence. Figure 1 shows average pulse shapes for CP 1919, CP 0950 and CP 1133. With the exception of those at 408 MHz these results were obtained at Parkes. The 408 MHz pulse shapes were obtained at Jodrell Bank by Lyne and Rickett. Circumstances of the observations are listed in Table I. Linearly polarized feeds were used at all frequencies.

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Footnotes:
For the Parkes observations a succession of pulses lasting several minutes was integrated by means of a 400-channel sequential integrating unit driven from a time base derived from a high-stability frequency synthesizer. The period for CP 1919 is triple with the leading sub-pulse dominating limited to 100 kHz at these lower frequencies to reduce intervals of 10-15 ms. As the frequency increases through the smearing effect of dispersion. In Figure 1 the leading edges of the pulses at the different frequencies have been arbitrarily aligned.

From Figure 1 it appears that the average pulse shape for CP 1919 is triple with the leading sub-pulse dominating at all frequencies and the following sub-pulses spaced at intervals of 10-15 ms. As the frequency increases through 408 MHz the third sub-pulse grows relative to the second.

Table I

<table>
<thead>
<tr>
<th>Frequency (MHz)</th>
<th>Bandwidth (MHz)</th>
<th>Date (1968)</th>
<th>Observers</th>
</tr>
</thead>
<tbody>
<tr>
<td>80</td>
<td>0.10</td>
<td>May-June</td>
<td>Present authors</td>
</tr>
<tr>
<td>150</td>
<td>0.10</td>
<td></td>
<td>Lyne and Rickett</td>
</tr>
<tr>
<td>408</td>
<td>1 and 4</td>
<td>March (?)</td>
<td>Robinson et al.</td>
</tr>
<tr>
<td>630</td>
<td>10</td>
<td>March</td>
<td></td>
</tr>
<tr>
<td>2700</td>
<td>150</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

From an examination of individual pulses, Drake has also noted the triple structure for CP 1919. In the case of CP 0950 there is no obvious change of pulse shape between 150 MHz and 408 MHz. The cleft at the pulse peak at 150 MHz is real, since it appears on all integrations with good signal-to-noise ratio, and this suggests that the pulse may be double. There is also a suggestion of a cleft in the 408 MHz pulse. The CP 1133 pulse is markedly double at all frequencies, but the spacing increases with increasing wavelength. This effect has been independently noted by Craft and Cornella.

The present results appear to contradict an interesting idea recently advanced by Drake and Craft. According to these writers, there is in addition to the well known and very stable period between main pulses, which they call $P_1$, a second period, $P_2$, associated with the sub-pulses. This second period is less stable and considerably shorter than $P_1$ and incommensurate with it. To explain the double periodicity they suggest that the source is a pulsating and rotating neutron star emitting highly-beamed radiation.

They identify $P_1$ with the rotation period and $P_2$ with the pulsation period. This idea leads us to expect the sub-pulses within successive main pulses to show a systematic and continuous change in their arrival times relative to a time base with a period $P_1$. Therefore the coherent integration we have carried out should completely obliterate the sub-pulse structure. It is clear, however, from Figure 1 that this has not occurred either for CP 1919 or for CP 1133.

Another result yielded by the coherent integration technique was a mean pulse energy for CP 0950 at 5000 MHz. From several integrations each of about 1000 pulses this was found to be $(6 \pm 2) \times 10^{-29}$ J m$^{-2}$ Hz$^{-1}$. Combining this with a value of $6 \times 10^{-29}$ J m$^{-2}$ Hz$^{-1}$, measured by Ekers and Moffet at 2295 MHz gives an energy spectral index of $-3.0 \pm 0.4$. Thus, although the spectrum of CP 0950 is fairly flat at frequencies up to about 400 MHz, there is a steep decrease between 2295 MHz and 5000 MHz similar to that shown by CP 1919 and CP 0834 at somewhat lower frequencies.

Pulsar Amplitude Variations
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Pulsars display a complicated pattern of amplitude variations. The scale of variations range from months through hours to sub-milliseconds. The purpose of this note is to present polarization data for CP 1919 and intensity distribution data for PSR 0833—45 which are relevant to pulse-to-pulse variations and the variation over periods of hours respectively.

The pulsar CP 1919 was observed at Parkes soon after the announcement of the original discovery. One of the observations was to observe simultaneously the total power and linear polarization (power difference) in crossed dipoles at 150 MHz. On occasions when the total power pulses were strong, pulses in the polarization channel would appear. These pulses indicate that at times very strong pulse-to-pulse polarization exists. A tracing of a record

![Figure 1](https://www.cambridge.org/core/journals/proc-asaa/article/pulsar-amplitude-variations/07A027DEC513C7B99B21BB8841A13DCE)