The drifting subpulse phenomenon is widely regarded as a powerful diagnostic tool in investigations of pulsar radio-emission mechanisms. We analyse single subpulses from PSR B0826-34 showing apparent changes of subpulse drift direction (Fig. 1), inconsistent with pulsar radio-emission hypothesis. We demonstrate that the emission behaviour is not genuine, and results from aliasing in sampling of the intensity fluctuations.Aliasing resolved, drifting subpulses in PSR B0826-34 provide first direct evidence of a system of sparks circulating on the polar cap. This pulsar is perfectly consistent with the Ruderman-Sutherland (1975) ISR drift model. The polar cap surface is heated by sparks to temperature $T > 10^7$ K, slightly below the critical ion temperature $T_i$ above which the thermionic emission of ion tions reaches the Goldreich-Julian charge density.

**PSR B0826-34**

The emission in PSR B0826-34 occurs in the entire pulsar period (Biagas et al., 1985), which indicates an almost aligned rotator, with the rotation and magnetic axes nearly parallel. Therefore, the observer's line-of-sight stays in the drift emission beam for most of the rotational period $P_r$. This provides a unique opportunity of scanning the polar cap along its circumference and, therefore, detecting radiation from a relatively large number $N$ of subpulse-associated beams of radio emission. These beams are believed to rotate around the magnetic axis in the time interval $P_r$, where $P_r$ is the usual drift periodicity (vertical separation between drift bands in pulsar periods $P_r$). Although the horizontal drift-band separation is known (P $\approx$ 307$+\Delta$ 3613$-\Delta$ 3627), the real value of $P_r$ (and therefore the value of the actual drift rate $D = P_r / P$) cannot be determined without aliasing resolution. However, we can first determine the number of involved subpulse subbeams, using the fact that the magnetic and the spin axes of the pulsar are nearly aligned. In such a case, the angular separation between adjacent sparks on the polar cap is almost the same as the observed $P_r$ and hence, $N \approx 630$. This yields a value of 14-sparks circulating on the polar cap.

**Simulations**

We can now simulate the radiation of PSR B0826-34, assuming that its single pulse structure reflects the circumferential motion of 14 sparks at a distance of about 33 meters from the pole. The spark-associated subpulses are emitted tangentially to dipolar field lines, at an altitude $r$ determined by radius-to-frequency mapping (Kiçil & Gil 1998).

The number of subpulses and their phases in a single pulse are determined by the angles $\alpha$ and $\beta$, as well as by the angular drift rate $D = 366/P$. Since the latter is not known a priori, we perform experiments with time varying drift rates, starting with $D=0$ and incrementing it by $\Delta D = 0.03$ every polar period $P_r$. Such value of $\Delta D$ was chosen to make sure that cycles of gradual variations of the drift rate have duration of about 100$\Delta D$, as observed. The idea is to find a sequence of about 100 pulses with varying $D$ at a range appropriate to produce curved drift-bands similar to those visible in Fig. 1.

The sample result of our simulations is presented in Fig. 2, with all important information written in the top panel and on both sides of the pulse window. The last column indicates the actual value of $P/360^\circ/D$, where $n$ is the subpale phase number indicated on the vertical axis. Next to $D$, we show values of $P_r/360^\circ/D_0$. On the other side of the pulse window we show values of $P/P_r/\pi/14^\circ$. And the column just next to it shows the fluctuation rate ($P/P_r/\pi/14^\circ$).

**What can we learn from simulated patterns presented in Fig 2?**

First of all, pulse n1 shows that were there no drift ($D=0$), the observer ($n=0.24$ and $P=1$) would clearly see 7 out of 14 sparks in the form of stationary longitude subpulses. As the drift rate increases with the increasing pulse number, the subpulse drift with time varying rate becomes more and more apparent. However, up to about pulse number n100, the subpulse drift is relatively slow, non-alised and proceeds from the leading to the trailing edge of the profile. This is the real drift direction and the observed drift-bands are formed by the same sparks/subpulses. This is, however, not true in the region well above pulsar n100, where all kinds of stroboscopic effects become visible. We have marked regions where the apparent drift-bands are formed by subpulses appearing at approximately the same phase every $P_r$-pulse period $n=54,3,2,1$ and so on. It is worth nothing that the number of apparent drift-bands is about 7. The drift-bands change the apparent drift direction due to the aliasing effect, every time $T_i$ crosses a multiple of the Nyquist frequency.

**Obviously,** the region below pulse n800 does not correspond to drifting subpulses in PSR B0826-34, because it shows alternating, longitude stationary intensity modulations, which are not observed in this pulsar. It seems, however, that its drifting subpulse patterns are well modelled by the region between pulses n800 and n900, which represents just one cycle of multiple subpulses. In Fig. 2A, a clear pattern of seven drift-bands is visible, moving in an aliased direction from the trailing to the leading edge in the first half of the cycle, and in the true direction from the leading to the trailing edge in the second half of the cycle. The drift direction change occurs at $t = (1/P_r)$ (or $(P/P_r)$, which is twice the classical Nyquist frequency. At this stage the carousel could consist of just one subpulse per one pulsar period $P_r$ and the apparent drift-bands are formed by successive adjacent subpulses. The corresponding values of $(P/P_r)$ and $D = 27.5^\circ/P_r$. However, 50 pulses earlier, at the beginning of a cycle, $P/3 = 14$ and $D = 27.5^\circ/P_r$, while 50 pulses later, at the end of a cycle, $P/3 = 13.3$ and $D = 27.1^\circ/P_r$. This means that the carousel speeds up along each cycle, increasing $D$ by about 8%. This can be converted into drift velocities of sparks circulating at a distance $d=33$ m from the pole. Since the speed $v = (1.8 \pm 0.8) \times 10^3$ m/s (at the beginning, at the reversal phase and at the end of a cycle, respectively.

**Ruderman & Sutherland model**

It is now desirable to check whether the derived drift velocity $v = 8 \times 10^3$ m/s is consistent with the Ruderman & Sutherland model, in which $v = c_0 \Delta n / B_0$ (1)

where $c$ is the speed of light, $r=7/3$ m is the polar cap radius, $B_0=2 \times 10^1$ G is the surface magnetic field at the pole, and $\Delta n = (n/50)^{1/2}$ m is the potential distance across the vacuum gap of height $h$. Thus, the actual drift velocity is $v = c_0 \Delta n / B_0$. The height of the gap $h$ is approximately equal to the separation between adjacent sparks. Since at $P_r$, the sparks cover this distance in exactly one pulsar period $P_r = 1.84$ s, moving with $v = 8 \times 10^3$ m/s, we can reasonably adopt that the effective gap height $h = P_r/1.84$ m. In PSR B0826-34, the estimated drift velocity $v = 8 \times 10^3$ m/s, in very good agreement with the observationally derived value $v = 8 \times 10^3$ m/s. The perfect agreement requires $h=13.3$ m, which implies the effective potential drop across the polar cap $\Delta V = 6.6 \times 10^1$ V. To explain the curved subpulse drift-bands this potential drop has to vary systematically by several percent during a 100 period cycles. The mechanism of these quasi-periodic variations remains to be understood.

Alternatively, the polar gap potential drop (Eq. 2) can be written in the Ruderman & Sutherland form $\Delta V = \eta [1.6 \times 10^1 (10^4 G)^{-1}] P^{-1} \eta V$. (3)

where $\eta = 1 - \eta / r/p$ is the screening factor, $\eta$ is the charge density of the thermionic $Fe^+ions$ and $p/r$ is the co-rotational Goldreich-Julian charge density. In the original RS paper $p/r$ and $\eta$, and 1, and a possibility of partial thermionic screening was proposed later as a natural model for the vacuum gap model (Cheng & Ruderman 1980). For the parameters of PSR B0826-34 ($P = 1.85$ s, $P_r = 10^1$), we obtain from Eqs. (1) and (2) that $\eta = 8 \times 10^3$ m/s, which is too much as constant for the above estimates of $v = 8 \times 10^3$ m/s. Simulations. We conclude that in PSR B0826-34 the actual value of the screening parameter $\eta$ is about 0.22, and thus $\eta$ is about 80% of the Goldreich-Julian charge density. However, since $\eta$ increases from 7.8 to 8.5 m/s during a 200 s cycle, $\eta$ should increase from about 0.21 to about 0.23, respectively. Following Cheng & Ruderman 1980, one can check that the screening factor $\eta = \exp[30 (1/T - T_i)]$, (4)

where $T$ is the so-called ion critical temperature, above which the thermionic ion flow reaches the Goldreich-Julian value and screens the gap completely, and the actual temperature of the polar cap surface heat by backlighting electrons produced by sparks. Taking $\eta = 0.21 - 0.23$ we obtain $T_i = 0.016 - 0.059$, thus the surface temperature is just a few thousands K below the ion critical temperature $T_i = 10^4K$. During the 200 s cycle this temperature drops by a value $\Delta T = 10^4 - 10^5$, indicating a cooling rate of about 5 K/s. However, after each cycle the temperature must rapidly rise back to about 10^5 K by the end of the cycle (as observed in the polar pulsar period). Such a minute cooling results in a severe percent increase of drift velocity, which can have a noticeable (even relativistic) effect on the drift patterns, when combined with aliasing effects of the kind inferred by us for PSR B0826-34. In pulsars with non-alised drift (e.g. PSR 0809+74) such small variations of the drift velocity do not affect the drift patterns, except perhaps for a slight bending of drift-bands. A detailed discussion of relativistic effects in a number of drifting subpulses is presented in Gil et al. 2003, gr. phr. 0305463.