CLOSING COMMENTS: OBSERVATIONS

W. SIEBER
Fachhochschule Niederrhein

Abstract

Many of the problems discussed at this conference were also on the agenda of the Bonn symposium on pulsars (IAU 95) about ten years ago, and it seems worthwhile to compare how our view of the magnetosphere and pulsar emission has changed since then.

It has been common to believe for a long time that the emission mechanism manifests itself mainly in the signature of single pulses, whereas integrated profiles are thought to reflect predominantly magnetospheric structure. Single pulses themselves are known to be highly variable on many time scales, and it seems that the shortest scale, the so-called microstructure, is related closest to the basic radiation mechanism. There were some remarkable papers presented at this conference on microstructure, which are impressive by their high signal-to-noise ratio, time resolution and sophisticated analysis procedures. It is not clear, on the other hand, that microstructure investigations have really solved the problem of the emission mechanism. There seems still to be a vast gap between observable features and structures explainable by existing theories.

This may be due to the fact that the basic radiation mechanism is thought to produce elementary pulses on an even shorter—not observable—time scale, often called submicrostructure, contributing in a stochastic way to microstructure pulses. It is striking that there seem to be no clear predictions from theories presented at this conference on microstructure or submicrostructure behavior. Naive observers, as myself, would assume that estimates of time scales, polarization signatures and other characteristics of elementary pulses would be the first quantities to be derived from basic radiation models.

Microstructure pulses add up to entities with time scales on the order of milliseconds, called subpulses. Considerable effort was spent in the past (and discussed at various meetings) in the investigation of subpulse behavior, clarifying, for example, the statistics of pulse-to-pulse intensity variations, cross correlations between emission peaks at different longitudes and pulses, polarization-angle swings, flips, and so on. Few of these investigations—with notable exceptions—have played a role at this conference, neither by presentations of new observing material nor in the framework of theoretical models.

Going upwards in emission timescale we come to single pulses. Here again a wealth of different phenomena may be investigated. It is known that some of the observed intensity variations at this and longer time scales are extrinsic, *i.e.* interstellar, but these effects were not the topic of this meeting. Fortunately, extrinsic and intrinsic variations seem to be separable due to different bandwidths and time structure. Pulse "nulling", for example, is certainly intrinsic and it was shown at this conference that the tendency for nulling cannot be correlated with any other measurable quantity of pulsars. It is remarkable how easy and fast pulsars can switch their emission on and off, a procedure which is obviously controlled by an unknown and up-to-now unmeasurable parameter.

Similar arguments apply to the so-called mode-switching phenomenon. Here again it is remarkable how easy transitions occur either between two stable integrated profiles or between an extended range of more or less, perhaps meta-stable, profile configurations. Here, too, the controlling parameter is unknown, although it is often believed that these changes reflect reconfigurations of the magnetosphere, not changes in the emission process. More, better, and multifrequency data are clearly needed to clarify the underlying physics.

Averaging out the stochastic variations of single pulses, one gets integrated profiles on time scales typically longer than a few minutes. Integrated profiles as individual and more or less time-stable (see below) signatures of pulsars were in the focus of interest at the beginning of pulsar research. Interest faded since then, giving way to single pulse investigations. It seems that we see a rebirth of integrated-profile analysis at this conference. One can find several reasons for this:

• The signal-to-noise ratio of many observations is nowadays exceedingly good, far better than that of older observations.

• The frequency coverage—insufficient in the past for most pulsars—has been extended to cover

https://doi.org/10.1017/S0002731600155647 Published online by Cambridge University Press

the lowest up to the highest frequencies for many pulsars, unraveling the full extent of pulse component structure and enabling us perhaps for the first time to classify pulsars unambiguously.

• Profiles at different frequencies are now very often compared taking into account the dispersion delay (time alignment), a procedure which was uncommon for earlier measurements. The determination of the phase delay is, unfortunately, not unambiguous: The phase shift between profiles may be evaluated if the dispersion measure is known exactly, for example, by software dedispersion of microstructure, or one has to know the individual phases accurately, *e.g.* by assumption of fiducial points, and one may then derive the dispersion delay. Both quantities cannot be derived simultaneously. There seems to be agreement at this conference that frequency dependent phase shifts of integrated profiles, *i.e.* deviations from the positions predicted from accurate dispersion measure estimates, have been observed unambiguously at high frequencies. These shifts may be explained by deviations of the magnetic field structure from a pure dipole geometry. Observations of integrated profiles should give us, therefore, in the future further and deeper insights into the magnetospheric structure of pulsars. If similar deviations exist at low frequencies is still a matter of debate.

• There are now many more and better polarization observations available. The broad success of the original single-vector rotation model is remarkable. It has been accepted as basic geometry of the magnetic field structure for nearly all pulsars, although one has to allow for 90° polarization position-angle flips. Integrated polarization structure including circular polarization, which plays a key role in the classification scheme of pulsars, has now been explained in the framework of theoretical models. The polarization behavior of single pulses, which often are thought to be more directly connected to the radiation mechanism and which were discussed in great detail in past conferences, are obviously not so easy to interpret.

Variations on even longer time scales, *i.e.*, more than several hours, have been shown to be at least partly extrinsic, caused, for example, by refractive scintillation. The question remains, if there is also an intrinsic component, *i.e.*, are pulsar intensity and polarization profiles as well as pulsar spectra really invariable? The vast amount of integrated profile data and pulsar spectra seems to confirm this (the binary pulsar being an obvious exception). Steep spectra with high frequency cut-offs and low-frequency turnovers for nearly all pulsars with the notable exception of fast (millisecond) pulsars seem now to be generally accepted characteristic features of pulsars incorporated in most pulsar models.

https://doi.org/10.1017/S0002731600155647 Published online by Cambridge University Press