THE DETECTION AND PROCESSING OF PULSAR SIGNALS AT DECAMETRIC WAVELENGTHS

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NOMENCLATURE

ALPHABETS

a	Characteristic scale size of electron density fluctuations.
a1	= ⟨A1⟩
a2	= ⟨A2⟩
a(t)	Calibrated profile.
Ampl,Amp2	Best fit amplitudes.
A3,A4	Random variables.
Ae	Effective aperture size.
Ao	New estimate using A1 and A2.
Aol,Ao2	Two independent estimates of a quantity.
A(I)	Bin contribution in Ith bin.
Ao(t)	COS channel output when $\Delta\theta = 0$.
Ac(t)	Average profile in COS channel.
As(t)	Average profile in SIN channel.
Ave(I)	Average profile over 2-period stretch.
b	$=(a1^2+a2^2)^{1/2}$
b1-->b8	8-bit binary number corresponding to ϕ_1
B	Predetection bandwidth.
B_o	Magentic flux density.
B5-->BO	6-bit output of the beam counter.
BFT	"Beam flipping time" in tracking.

Bopt	Optimum bandwidth,
B(t)	Sample value at time t.
	The velocity of light.
	Mean number of samples averaged.
Cji	1-bit control signal for phase shifter.
C(I)	Effective number of samples averaged in Ith bin.
	Distance to a pulsar.
d'	Constant to account for average gain of the EW beam over 30' arc.
d1	Distance between two basic array elements in E-W direction.
d(t)	The receiver bandpass converted into time function by the dispersion law.
$(df/dt)_d$	Drift rate due to $A P \neq 0$.
$(df/dt)_{sw}$	Sweep rate of the SLOS.
Do	Calibrator deflection corrected for collimation error.
Dc	Calibrator deflection in COS channel.
DM	Dispersion Measure.
Dn	Deflection due to calibration noise.
Ds	Calibrator deflection in SIN channel.
e	Charge of an electron.
f,f1,f2	Radio frequencies in Hz.
f_o	Centre frequency of observation.
f_{clk}	Sampling clock frequency.
fs,fe	Start and end frequency of the sweep.

f_{in}, f_{χ}	First and second input frequency.
f_{LF}	Frequency of low frequency signal.
f_{RF}	Frequency of RE' signal.
f(t)	Staircase function as an approximation to $f_{t}(t)$.
f_{out} (t)	Output frequency of the sweeping LO system.
$f_{t}(t)$	Required frequency.
F(t)	Best fit profile.
g_{c}	Gain factor due to collimation error.
$\overline{g}$	Average gain.
g(n)	Actual gain function in the frequency domain.*
g(t)	Best fit function to an observed profile.
g_{o} (n)	Crude estimate of g(n).
gl(n)	Modified gain function.
g'(n)	Effective gain function in the frequency domain.
G_{a}	Gain function of the telescope upto mixer stage.
G_{b}	Gain of the baseband filter.
G_{c}	Gain of the correlation beam.
Ge,Gw	Phase gradients for East and West arrays.
|G|max	Maximum value of the phase gradient,
	Running index.
i(t)	Function representing intrinsic pulse profile.
	Integral number of bins in the fraction of the Np-period stretch.
$\overline{I}_{B}$	Average intensity of the background radiation.
ICH	Channel index.
$\overline{I}'_{B}$	Background noise intensity off the source.

$I(t)$	Intensity due to a pulsar signal at the output of a receiver.
$\bar{I}(n)$	Average intensity pattern in frequency domain.
$I_B(f_{RF},t)$	spectral desnity of background radiation at the antenna input.
$I_{off}(n)$	Measured intensities off the source.
$\bar{I}p(\phi_s(n))$	Average intensity of a pulsar signal at longitude $\phi_s(n)$.
$Ip(f_{RF},t)$	Spectral density of a pulsar signal at the input of the Antenna.
k	Boltzman's constant.
k_o, k'	Constants.
K	System gain normalization factor.
K_o	A constant.
L	Lower sideband intensity.
L_o	Integer number.
L_c	Length of a phase cable.
L_{EW}	Length of the EW array.
m	Mass of an electron.
m'	Receiver dependent constant.
$\bar{m}$	Modulation index.
n,n'	Bin index.
n_o	Number of observations.
$n1,n2$	Zero mean random noise processes.
n_b	Beam position.
n_e	Electron density.

$\hat{n}$	Step number corresponding to the SLOS frequency.
$\hat{n}_s$	Step number corresponding to f_s.
n_{samp}	Number of independent samples averaged after post-detection integration.
$n_d(t)$	Number of bins by which pattern drifts in time t.
N	Divisor value.
NB	Number of output bins.
NCH	Number of channels.
N_d	Number of drift cycles.
Nj	Divisor value for jth stage.
Np	Number of periods over which data is averaged.
Nrec	Number of records used for averaging.
N_S	Integral number of Np-period stretches.
P	Apparent period of a pulsar,
P'	Sweep reset interval.
$\dot{P}$	First derivative of pulsar period.
$\ddot{P}$	Second derivative of pulsar period.
Po,Pl	Pulsar period as would be observed at the Barycentre of the Solar System (BSS) at epochs t_o ,tl.
P_{noise}	Average power due to background noise.
Q	Level of detection.
r_o	The classical radius of electron.
r_p	Spatial scale of a diffraction pattern at the Earth.
$\vec{r}$	Unit vector along the line of sight to a pulsar.

r(t)	Impulse response of the pust-detection filter.
R("x")	Beam pattern in "x" mode.
RA	Right Ascension.
Rcal	Calibration factor (Jansky/count of deflection).
RM	Rotation measure.
$R_g(\theta_m)$	Ratio of the secondary response to the main response of the EW array.
ReL 3	Real part.
s(t)	Impulse response due to interstellar scattering.
$\overline{S}$	Average of Si.
S	Source strength in Jansky.
$(S/N)_{Ai}$	Signal-to-noise ratio for Ai.
SINC(Y)	= SIN(Y)/Y
Si	Pulse energy estimate in ith observation.
SLOS	Sweeping Local Oscillator System.
t	Time co-ordinate.
t_0 ,t1	Epochs.
t1,t2	Pulse arrival times.
t'	= t-iP (for i=0,1,..), such that $0 \leq t' < P$
t"	= t'/DM
t_{off}	Duration of off-source observation.
t_{on}	Duration of on-source observation.
ts,te	Start and end time for tracking.
Ts	Sampling interval.
Tsys	System noise temperature.
U	Upper sideband intensity.

V_d Projected velocity of an observatory in the direction of a pulsar.

$\vec{V}_E$ A velocity vector representing the velocity of the geocentre with respect to the BSS.

V_g Group velocity.

$\vec{V}_{obs}$ Velocity of an observatory with respect to the geocentre.

V_s Velocity of the earth-pulsar line across the scattering screen.

V_x, V_y, V_z Components of $\vec{V}_E$.

V(t) Complex envelope associated with X(t).

Undispersed pulse width.

W1,W2 Weightages.

A constant with value close to unity.

X(t) Varying voltage due to a pulsar signal.

Y $(Amp1^2 + Amp2^2)^{1/2}/g_c$

Zenith angle.

Greek Symbols

β Velocity factor of the cable.

γ Increase in time resolution.

δ Declination.

δf Spectral resolution or binwidth.

$\delta f(t)$ Error in f_{out}.

δt	Additional smearing in tinie.
$\delta \Psi$	Difference between Faraday rotation angles at the extreme frequencies within a band ΔF.
Δ BFT	Absolute quantization error in representing BFT.
A f	Bandwidth over which a pulsar profile over one period gets mapped in frequency.
ΔF	f2 - fl
$\Delta g(n)$	Error in the estimation of g(n).
ΔI	Fraction of the bin.
$\Delta I_{off}(n)$	Error in the estimation of $I_{off}(n)$.
Δ Ip	Uncertainity in estimation of Ip() .
Δn_e	Electron density fluctuations.
ΔP	Deviation of reset interval(P') from P.
Δ RA	Absolute quantization error in representing RA.
Δt	Step width in f(t).
Δt	t2-tl
Δt_{bin}	Binwidth in time.
Δt_q	Worst case error in ts,te due to Δ RA and Δ BFT.
Δ Tsamp	Sampling interval.
$\Delta \theta$	Effective collirnation error in N-S direction.
$\Delta \Psi$	Faraday rotation angle.
$\Delta \nu$	Decorrelation bandwidth for interstellar scintillation.
$\Delta \phi$	r.m.s. phase deviation due to scattering.
η	Delay decorrelation factor.
θ	Angle between the line of sight and the

direction of interstellar magnetic field.

θo Apparent angular semidiameter of a source due to scattering.

θ_b Peak to first null separation of the basic array element beam in EW direction.

θ_m Angular tilt from the meridian.

θ_{NS} Peak to first null separation of the S arm beam in NS direction.

θ_S Scattering angle.

λ Wavelength.

ρ_a Normalized analog correlation.

ρ_c Normalized one-bit correlation.

σ_T Estimate of the standard deviation of noise in the profiles Ac(t),As(t).

σ Standard deviation due to noise.

$\sigma 1, \sigma 2$ r.m.s. noise in the estimates Aol and Ao2.

σi Standard deviation of data in ith record before averaging.

σo r.m.s. noise deviation in the Ao.

σ_N Standard deviation of A4 from its true value b.

σ Standard deviation of noise in output profile.

τ Post-detection integration time.

$\bar{\tau}$ Mean uncompensated delay.

τmax Maximum delay.

τ_{on} On-line integration time.

τ_d Decorrelation time for interstellar

scintillations.

τ_s Characteristic width of the impulse response due to scattering.

ϕ Phase shift.

1 - Phase shifts required for tracking.

$\phi_s(n)$ Longitude of a pulsar signal at frequency $(f_s + n\delta f)$ and time $t = 0$.

ω Frequency in radians per second.

Plasma frequency in radians per second.

Suffix

max Maximum value.

min Minimum value.

r.m.s. Root mean squares.

Other Symbols

Frac( ) Fraction.

Int( ) Interger part.

$\sum$ Summation.

| | Magnitude.

$*$ Convolution.

Dot product.

⟨ ⟩ Ensemble mean.