 

**Refutation of gravitational waves from pulsars by daily-averaged-weighted random residuals**

We assume the method and apparatus of Meth8/VŁ4 with Tautology as the designated proof value, **F** as contradiction, N as truthity (non-contingency), and C as falsity (contingency). The 16-valued truth table is row-major and horizontal, or repeating fragments of 128-tables, sometimes with table counts, for more variables. (See ersatz-systems.com.)

LET ~ Not, ¬ ; + Or, ∨, ∪, ⊔ , | ; - Not Or; & And, ∧, ∩, ⊓, ·, ∘ , ⊗ ; \ Not And, ↑ ;
> Imply, greater than, →, ⇒ , ↦, ≻, ⊃, ↠ ; < Not Imply, less than, ∈, ≺, ⊂, ⊬, ⊭, ←, ≲ ;
= Equivalent, ≡, :=, ⇔, ↔, ≜, ≈, ≃ ; @ Not Equivalent, ≠, ⊕ ;
% possibility, for one or some, ∃, ∃!, ◊, M ; # necessity, for every or all, ∀, □, L ;
(z=z) T as tautology, ⊤, ordinal 3 ; (z@z) **F** as contradiction, Ø, Null, ⊥ , zero ;
(%z>#z) N as non-contingency, Δ, ordinal 1 ; (%z<#z) C as contingency, ∇, ordinal 2 ;
~( y < x) ( x ≤ y), ( x ⊆ y), ( x ⊑ y); ~( x < y) ( x ≥ y); (A=B) (A~B).
Notes: for clarity, we usually distribute quantifiers onto each designated variable; and for ordinal arithmetic, the result is implied.

From: Agazie, G.; et al (too many to count). (2023). The NANOGrav 15 yr data set: observations and timing of 68 millisecond pulsars. Astrophysical journal letters. 951:L9.
arxiv.org/pdf/2306.16217.pdf

In papers relying on data tables, a component can be checked for randomness using the N-by-M contingency test, a superset of the Chi-squared test, where expected values are derived from the observed values. For calculations of time of arrival (TOA), we evaluate the statistic named rms (root mean square) for narrowband from Table 6 in Appendix C, with the fragment of its last page below.

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**Table 6**
(Continued)

| Source | Number of TOAs | Number of Fit Parameters[b] | | | | | | rms[c] ($\mu$s) | | Red Noise[d] | | | Figure Number |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | S | A | B | DM | FD | J | Full | White | $A_{red}$ | $\gamma_{red}$ | $\log_{10}B$ | |
| | 400 | 3 | 5 | 7 | 161 | 0 | 1/2 | 1.045 | 0.358 | 0.068 | −2.4 | >2 | |
| J2214+3000 | 7425 | 3 | 5 | 5 | 96 | 2 | 1 | 0.407 | ··· | ··· | ··· | −0.13 | 68 |
| | 293 | 3 | 5 | 8 | 102 | 4 | 1/2 | 0.456 | ··· | ··· | ··· | 1.48 | |
| J2229+2643 | 3716 | 3 | 5 | 6 | 76 | 2 | 1 | 0.280 | ··· | ··· | ··· | 0.02 | 69 |
| | 151 | 3 | 5 | 6 | 77 | 5 | 1/2 | 0.231 | ··· | ··· | ··· | −0.07 | |
| J2234+0611 | 3566 | 3 | 5 | 8 | 66 | 2 | 1 | 0.200 | 0.071 | 0.038 | −1.2 | >2 | 70 |
| | 133 | 3 | 5 | 8 | 66 | 0 | 1/2 | 0.061 | ··· | ··· | ··· | 1.90 | |
| J2234+0944 | 7535 | 3 | 5 | 5 | 72 | 2 | 1 | 0.197 | ··· | ··· | ··· | −0.17 | 71 |
| | 245 | 3 | 5 | 5 | 74 | 0 | 1/2 | 0.796 | 0.209 | 0.176 | −0.1 | >2 | |
| J2302+4442 | 10,211 | 3 | 5 | 7 | 108 | 3 | 1 | 0.764 | ··· | ··· | ··· | −0.05 | 72 |
| | 236 | 3 | 5 | 7 | 108 | 0 | 1/2 | 0.710 | ··· | ··· | ··· | −0.03 | |
| J2317+1439 | 13,942 | 3 | 5 | 6 | 303 | 3 | 2 | 0.345 | ··· | ··· | ··· | −0.09 | 73 |
| | 711 | 3 | 5 | 6 | 309 | 0 | 2/3 | 0.690 | ··· | ··· | ··· | 0.01 | |
| J2322+2057 | 3088 | 3 | 5 | 0 | 59 | 1 | 2 | 0.255 | ··· | ··· | ··· | −0.25 | 74 |
| | 130 | 3 | 5 | 0 | 59 | 0 | 2/3 | 0.262 | ··· | ··· | ··· | −0.13 | |

**Notes.**
[a] The first line for each pulsar is from the narrowband analysis, and the second line is from the wideband analysis.
[b] Fit parameters: S = spin; A = astrometry; B = binary; DM = dispersion measure; FD = frequency dependence; J = jump (two numbers indicate wideband data with JUMPs/DMJUMPs).
[c] Weighted rms of epoch-averaged post-fit timing residuals, calculated using the procedure described in Appendix D of NG9. For sources with RN, the "Full" rms value includes the RN contribution, while the "White" rms does not.
[d] RN parameters: $A_{red}$ = amplitude of RN spectrum at $f = 1$ yr$^{-1}$ measured in $\mu$s yr$^{1/2}$; $\gamma_{red}$ = spectral index; $B$ = Bayes factor (">2" indicates a Bayes factor larger than our threshold $\log_{10} B > 2$, but which could not be estimated using the Savage–Dickey ratio). See Equation (3) and Appendix C of NG9 for details.

For footnote [c] Weighted rms of epoch-averaged post-fit timing residuals, the reference text is:

From: Arzoumanian, Z., et al. (too many to count). (2015). Astrophysical journal. 813:65. Appendix D. arxiv.org/abs/1801.01837

determine the maximum likelihood timing model parameters and the maximum likelihood red noise realization present in the data via the equivalent of a generalized least squares fit. We can also evaluate the posterior of the hyper-parameters $\phi$ and thus find the maximum likelihood noise parameters including the EFAC, EQUAD, ECORR, red noise amplitude $A_{\rm red}$, and spectral index $\gamma_{\rm red}$. The posterior distributions of the noise parameters are sampled using a Markov Chain Monte Carlo process in which we sample some parameters in $\log_{10}$ space and limit them to $\log_{10} J_k \in [-8.5, -4]$, with $J_k$ in units of

## APPENDIX D DAILY AVERAGED RESIDUALS

For modern wide-band timing campaigns using multi-channel TOAs it becomes useful to visually inspect timing residuals that have been averaged in order to look for long term trends or biases. Here we derive a robust weighted average that will fully account for short timescale correlations introduced by the ECORR in our noise models. This is important since ECORR is meant to model pulse phase jitter, thus when constructing

daily averaged residuals, one must include this effect as it results in larger averaged uncertainties on the averaged residuals. In essence this allows for a way to visually determine which pulsars may be dominated by pulse phase jitter.

We begin the derivation by introducing the probability distribution of the group of residuals that belong to time bin[38] $k$,

$$p(\delta t_k | \bar{\delta t}_k) = \frac{\exp\left[-\frac{1}{2}(\delta t_k - O\bar{\delta t}_k)^T C_k^{-1}(\delta t_k - O\bar{\delta t}_k)\right]}{\det(C_k)}, \quad (33)$$

[38] In this work, we have used time bins of size 1 s, thus are only averaging sets of multi-channel residuals measured simultaneously.

where $\delta t_k$, $\bar{\delta t}_k$, and $C_k$ are the residuals in time bin $k$, the mean residual in time bin $k$, and the covariance matrix of the residuals in time bin $k$, respectively. Here, $O$ is the design matrix for the mean which in this case is a vector of ones of length $N_k$, where $N_k$ is the number of residuals in simultaneous time bin $k$. In an identical manner as Appendix C we can determine the maximum likelihood estimator and uncertainty for the mean of the probability distribution function (i.e., the daily averaged residual)

$$\bar{\delta t}_k^{\rm ML} = \left(O^T C_k^{-1} O\right)^{-1} O^T C_k^{-1} \delta t_k \quad (34)$$

$$\bar{\sigma}_k^2 = \left(O^T C_k^{-1} O\right)^{-1}, \quad (35)$$

where $\bar{\sigma}_k$ is the weighted uncertainty on the daily averaged residual. Note that if $C_k$ is diagonal with elements corresponding to the TOA uncertainties then we obtain our usual expression for the weighted mean and standard deviation

$$\bar{\delta t}_k^{\rm ML} = \frac{\sum_{i=1}^{N_k} \delta t_{i,k} \sigma_{i,k}^{-2}}{\sum_{i=1}^{N_k} \sigma_{i,k}^{-2}} \quad (36)$$

$$\bar{\sigma}_k^2 = \left(\sum_{i=1}^{N_k} \sigma_{i,k}^{-2}\right)^{-1}, \quad (37)$$

where $\sigma_{i,k}$ is the TOA uncertainty for the $i$ TOA in simultaneous time bin $k$. We note that the ECORR will add to the off-diagonal components of $C_k$ and can have a large impact depending on the relative strength of ECORR compared to the radiometer noise component.

Here are the DATA input statements in TrueBASIC for Tab. 6 of the 68 values of rms.

```
DATA   326,  856,  597,  176,  186,  695,  353, 1153, 1703,  749,  276,  664, 1592, 1165
DATA   286,  415,  925,  708, 2835,  239,  688,  731,  783,  735,  271,  354,  271,  200, 2335, 1124,  201, 2471,  277,  262,  182,  505,12519
DATA  3214,  560, 2247,  220,  214,  220,  337,  829, 3737,  303,  413,   74,  338,  280, 5774,  461, 1387, 1158,  274,  109,  468,  115,  338,  799
DATA   407,  280,  200,  197,  764,  345,  255
```

The decimals are inserted to match the text by scaling the integer input by "/ 1000". The source code of the N-by-M contingency test is available at https://ersatz-systems.com/chi2.source.code.pdf .

For a 2-column by 34-row table, the Chi-squared value is 30.381911, df=33, and P=0.59402070 which is a random probability.* The slicing and dicing of numbers for the column and rows as factors to equal 68 also produces non-significant results.

This means the 15-year study, even *after* the data-manipulation steps of weighting "epoch-averaged post-fit timing residuals", found exactly what should be expected, namely randomness, and hence nothing statistically significant. Therefore, once again, the return on investment for a result of randomness from provably junk-science research is unremarkable.

* For the general verification of interpolated Fischer P by Chi-squared value and degrees of freedom, see this handy table of *Critical values of chi-square (right tail)* at https://www.scribbr.com/wp-content/uploads/2022/05/Chi-square-table.pdf .