# Discrete DMs in FRBs: Testing the hypothesis

M. Hippke, W. F. Domainko, J. G. Learned

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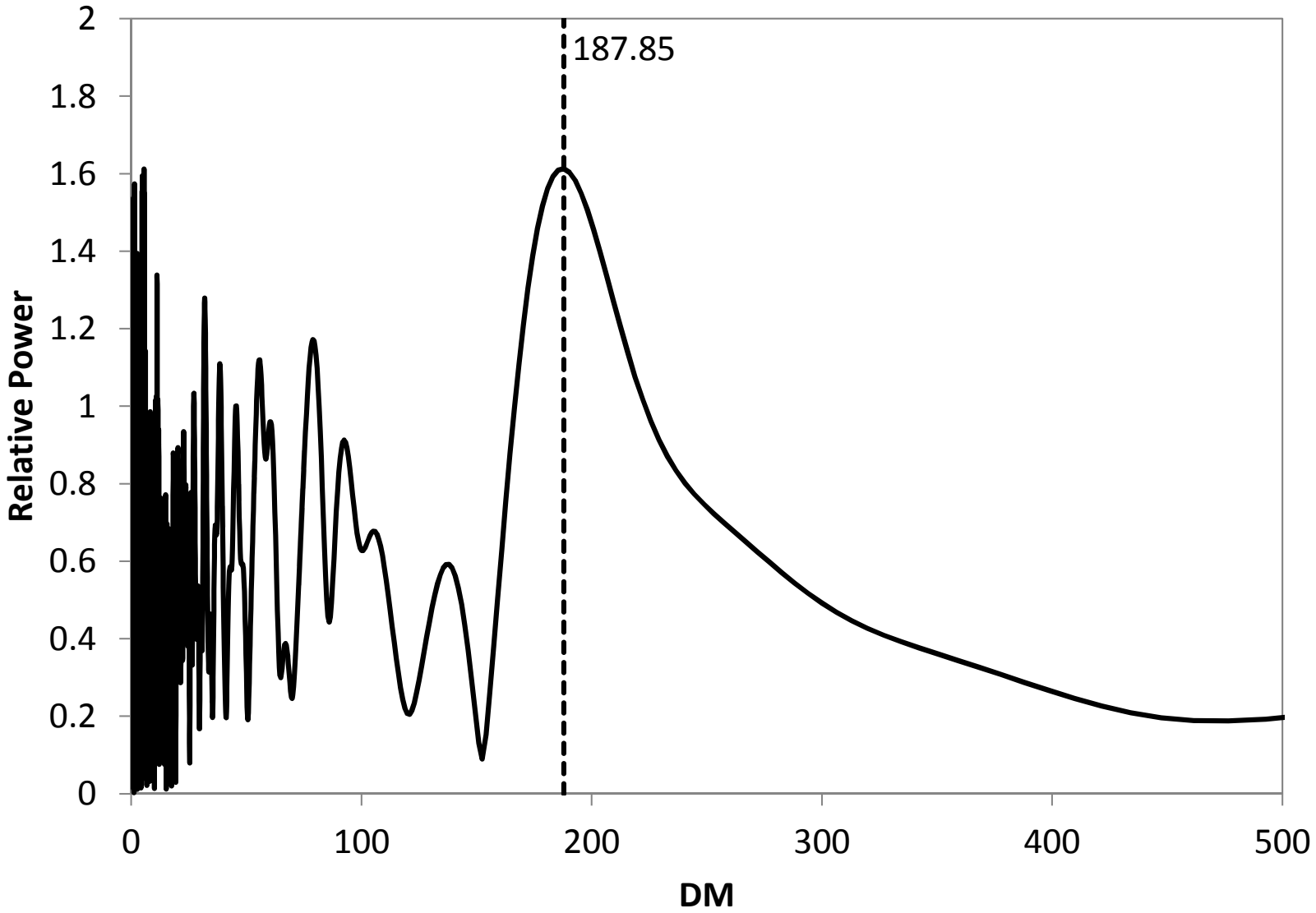
# Hypothesis predictions

- Hypothesis: FRB DMs are clustered around multiples of 187.5
- We would prefer FRBs to be cosmological: Much more interesting than interference
- But: We don't know much about their origin. Alternative, *falsifiable* hypotheses are valid tools in science

# Who's involved?

- Michael Hippke, Wilfried F. Domainko, John G. Learned (http://arxiv.org/abs/1503.05245)
- Previous work in other fields:
  - Michael Hippke: RR Lyrae (ApJ, 798, 42), Strange nonchaotic stars (Phys. Rev. Lett. 114, 054101), Exomoons (ApJ in press)
  - Wilfried F. Domainko: 168 publications, mostly in Gamma-Ray Astronomy, H.E.S.S.
  - John G. Learned: 426 publications, mostly in Neutrino research

# Lomb-Scargle data analysis (using 10 FRBs)



# Evaluation of significance

Null hypothesis: 10 DMs drawn from a uniform distribution [300..1200]. Test statistic is the sum of squared errors between each DM and the nearest integer $\times$ min(DM)/2. This prior gives p=0.007:

```
#FRBs
val <- numeric(10)
x.obs <- c(375,553,557,562,723,746,779,790,944,1103)
for (i in 1:10) {val[i] <- min((x.obs[i]-min(x.obs)/2*seq
    (1,16))^2)}
test.statistic.obs <- sum(val)

#Random sample
test.statistic <- numeric(10000)
for (j in 1:10000) {x <- runif(10,300,1200); for (i in 1:10)
    {val[i] <- min((x[i]-min(x)/2*seq(1,16))^2)}; test.
    statistic[j] <- sum(val)}
p.value <- length(which(test.statistic < test.statistic.obs))
    /10000
```

Other priors (uniform, Gaussian, range...) will give other *p*-values.

# Method for falsification

- New FRBs required for the test: Are they within $\pm 5\%$ of $n \times DM_{try} = 187.5$?
- Evaluate hypothesis with binomial probability (next slide)

| FRB# | DM | DM/187.5 | Hit? |
|---|---|---|---|
| 150215 (Parkes) | 1104 | 4.13 | no |
| 150418 (Parkes) | 776 | 5.89 | no |
| 110523 (GBT) | 623 | 3.32 | no |
| 090625 (Parkes) | 897 | 4.78 | no |
| 130626 (Parkes) | 952 | 5.07 | yes (?) |
| 130628 (Parkes) | 469 | 2.50 | no |
| 130729 (Parkes) | 860 | 4.58 | no |

FRBs: 7

- Hits: 1
- No hits: 6

# Probability table for $\pm 5\%$

| Hits \ FRBs | 4 | 5 | 6 | 7 |
|---|---|---|---|---|
| 1 | 0.34 | 0.41 | 0.47 | 0.52 |
| 2 | 0.05 | 0.08 | 0.11 | 0.15 |
| 3 | small | small | 0.02 | 0.03 |
| 4 | small | small | small | small |
| 5 | | small | small | small |
| 6 | | | small | small |
| 7 | | | | small |

# What might worry, or help us

☹Distribution dependence to galactic latutide $b$ (is it real?)

☹Check data for negative DMs (upchirp, upsweep)

☹A potential man-made, e.g. military source:

- Might be the same in Australia and Puerto Rico, but different in Germany
- Should create inconsistent burst rates, e.g. Effelsberg vs. Parkes
- Can be close (e.g. airplane, Lorimer burst) and far (mil-sat, Arecibo), even reflected (e.g. off the moon? c.f. Arecibo)
- Should be *much* brighter at higher frequencies (e.g. 9.6 GHz downchirp)

☺Multi-telescope campaign - a second (smaller) dish $>$ 100km away can exclude most man-made sources (airplane, mil-sat...)

☺$\mathrm{DM}_{total}=\mathrm{DM}_{galactic}+\mathrm{DM}_{intergalactic}$

- In a plot of $\mathrm{DM}_{total}$ versus $\mathrm{DM}_{galactic}$, we should see a positive trend
- Current data is insufficient; needs $\sim$50 FRBs for $p < 5\%$

# Conclusion

- Hypothesis is likely to be incorrect
- Theories should always be falsifiable in order to be valid & useful science
- Thank you for your respect and invitation