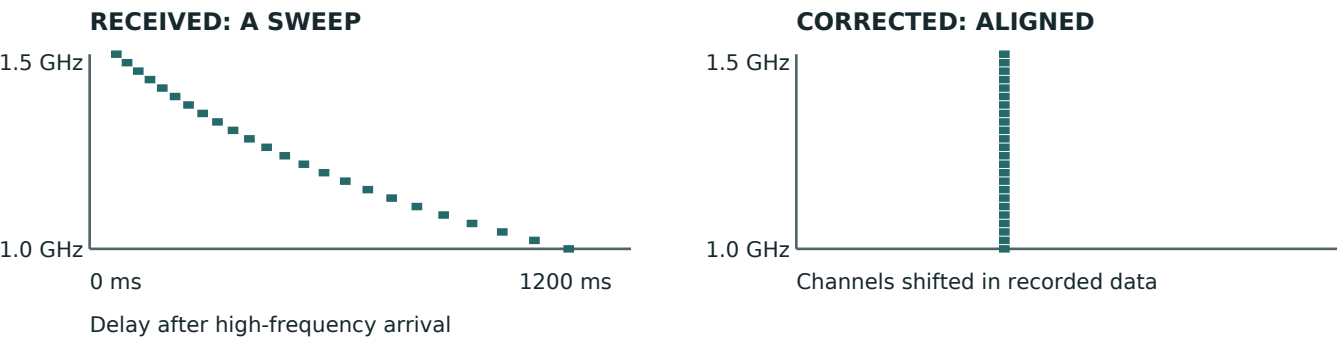


Investigate a Mystery Radio Signal

Name: _____ Group: _____ Date: _____

All six records, galaxies, positions and follow-ups are invented for learning. They are not measurements of an observed fast radio burst (FRB).

GOAL: Align radio channels, compare signal patterns, then defend a conclusion with evidence and a limitation. Suggested ages 12+; 35-45 minutes.



LIVE LAB darksciencedocs.com/light-lab/fast-radio-burst/

1. Predict the sweep direction before touching the slider. 2. Start with Case 01 at trial DM 0. Adjust Trial dispersion measure until channels align and the summed pulse is narrow. 3. Read the follow-up, request sharper localization, and record your host decision. 4. Compare Cases 02 and 04. Extension: Cases 03, 05 and 06.

Observe first; consult the answer discussion on pages 3-4 afterward. For paper-only work, use the fictional clues on page 2.

OBSERVATION RECORD (DM units: pc cm⁻³; delay units: ms)

Case	Best DM	Band delay	Pattern / follow-up clue	Host / source limit
01				
02				
04				

Prediction: Why should a useful correction make the frequency channels align?

Clues, comparisons and a claim

PAPER-ONLY CASE CARDS / These are supplied fictional observations and follow-ups. They are also available in the live lab. Do not treat the supplied host match as a real probability calculation.

01 / The swept flash - One broadband swept pulse; lower-frequency arrival is about 1106 ms later across 1.5 to 1.0 GHz. No additional burst in a limited follow-up. The sharper synthetic position region favors Galaxy B, assigned redshift 0.65.

02 / A suspicious visitor - A broadband pulse with no injected sweep, together with persistent narrow-frequency contamination. Independent follow-up does not recover a stable celestial position.

03 / It happened again - Three dispersed pulses, irregularly separated by 250 ms then 380 ms after correction; band delay is about 1890 ms. Additional irregular bursts return at the same position and DM. The sharper region favors Galaxy A, assigned redshift 0.18.

04 / The radio clock - Five pulses with a regular 180 ms cadence after correction; band delay is about 277 ms. The cadence persists over a longer observation and the position matches a catalogued Milky Way pulsar.

05 / The lingering echo - A dispersed pulse retains an asymmetric fading tail after its fronts align; band delay is about 1475 ms. Lower-frequency tails remain longer after correction. The sharper region favors Galaxy C, assigned redshift 1.10.

06 / A thin-band intruder - A pulse occupies only six of the 48 frequency channels and has no injected sweep. Independent follow-up does not recover a stable celestial position.

OPTIONAL CALCULATION / Across 1.0 and 1.5 GHz, delay (ms) = $4.148808 \times \text{DM} \times (1/1.0^2 - 1/1.5^2)$. A delay near 1106 ms suggests DM near 480 pc cm⁻³. This is an electron-column clue, not a unique distance.

YOUR CLAIM / Choose one case. State a conclusion, cite two clues and give one limit.

NEXT TEST / What additional observation would help, and what outcomes would change your claim?

Suggested answers, with limits

These values are injected model settings, not calibrated measurements. Approximate alignment is acceptable. The lab awards full DM points within 15 of the injected value; its score is not scientific confidence.

01 / The swept flash | DM 480 pc cm⁻³

Isolated dispersed burst candidate; Galaxy B is favored in this toy position test. The burst engine remains unresolved. **Limit:** One recorded burst does not establish that its source never repeats.

02 / A suspicious visitor | DM 0 pc cm⁻³

Broadband interference is favored by the combined clues. Assign no host galaxy and no established sky engine. **Limit:** Zero DM alone is not a universal interference test.

03 / It happened again | DM 820 pc cm⁻³

Repeating burst candidate; Galaxy A is favored in this toy test. Repetition does not uniquely identify the emission engine. **Limit:** The repeated activity supports recurrence, not a confirmed magnetar or transmitter.

04 / The radio clock | DM 120 pc cm⁻³

A periodic Galactic pulsar: the combined timing and positional follow-up supports a rotating neutron star. Assign no host galaxy. **Limit:** A short regular pulse train alone would still need follow-up.

05 / The lingering echo | DM 640 pc cm⁻³

Scattering-broadened burst; Galaxy C is favored in the toy test. Channel shifts correct dispersion, while multipath arrival-time spreading remains. **Limit:** This propagation clue does not uniquely identify the burst engine.

06 / A thin-band intruder | DM 0 pc cm⁻³

Narrowband interference is favored by limited frequency coverage plus failed celestial follow-up. Assign no host galaxy. **Limit:** Narrow bandwidth alone is not decisive evidence of interference.

COMMON MISCONCEPTIONS

A taller summed peak does not give a calibrated detection significance. A high DM is not a sky position or a unique distance. A narrowband pulse is not automatically interference. Repetition does not uniquely identify a magnetar. The pulsar identification here depends on the supplied longer timing record and catalogued positional match.

Teach the reasoning, not the score

Suggested sequence: 5 minutes prediction and axes; 15 minutes Cases 01, 02 and 04; 10 minutes claim, evidence and limits; 5-15 minutes discussion or extension cases. One shared screen or printed case cards can support group work. Calculator use is optional.

ASSESSMENT / Award 0-2 points each for an evidence-matched claim, two relevant clues, a meaningful limitation and a useful next test (8 points total). Accept equivalent reasoning. This classroom rubric is separate from the lab game score; neither is a probability of scientific truth.

KEEP FOUR QUESTIONS SEPARATE

Dispersion correction aligns frequency-dependent arrivals. Array timing and phase measurements constrain sky direction. A defensible positional association links a burst to a host, whose spectrum can supply redshift. The emission engine requires additional evidence. The lab provides a simplified position region, not real interferometry, a chance-alignment analysis or a calibrated confidence level.

Extension: What would another burst at the same position establish? What if a proposed host lay outside a better localization region? Ask learners to specify outcomes that would change their conclusion. In Case 05, aligning pulse fronts leaves the injected multipath tail; dispersion and scattering describe different propagation effects.

BACKGROUND SOURCES / The case data are original fictional teaching records.

1. Petroff, Hessels and Lorimer: Fast Radio Bursts, section 2

<https://ned.ipac.caltech.edu/level5/March19/Petroff/Petroff2.html>

2. CHIME: science and fast radio bursts

<https://chime-experiment.ca/en/science/>

3. NASA: Pulsars

<https://science.nasa.gov/mission/hubble/science/science-behind-the-discoveries/hubble-pulsars/>

4. NASA: the FRB 20240304B host investigation

<https://science.nasa.gov/missions/webb/webb-measures-distance-to-farthest-fast-radio-burst-suggesting-origin/>

Share the complete activity with attribution to The Last Transmission and source links intact. Read the online activity for accessible text, sources and the current packet:

darksciencedocs.com/exploration-guides/investigate-a-mystery-radio-signal/