UAP & Drone Footage: Propulsion Signature Field Guide

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1) What a genuine propulsion signature looks like (by sensor)

Visible / NIR
- Combustion jets/rockets: Luminous exhaust (often structured “shock diamonds” in jets), sometimes faint exhaust shimmer in high zoom. Navigation light patterns (manned aircraft: red left, green right, white tail; anti■collision strobes) are strongly diagnostic of conventional aircraft. Small UAS at night require an anti■collision strobe visible ≥3 SM but not the red/green/white triad.

IR / Thermal (MWIR 3–5 µm, LWIR 8–12 µm)
- Jet/turbine exhaust: Hot CO■/H■O bands dominate. In MWIR, plumes tend to be very bright and contrasted, often brighter than the airframe (especially in afterburner). In LWIR, the cooler airframe surfaces often dominate unless power is high. Expect strongest bands near ~2.7 µm (H■O) and ~4.3 µm (CO■).
- Rockets: Even stronger line/continuum emission (H■O, CO■, sometimes CO). MWIR bands are especially prominent; plume brightness and spectral structure depend on propellant and altitude.
- Electric multirotors (consumer/pro): Weak thermal signatures at range. You’ll mainly see slightly warm motors, battery, and ESCs; beyond a few meters, the “blob” often collapses to a single warm core. No hot plume and no MWIR■bright exhaust.
- Balloons/loose objects: Often show reflective or cool signatures; contrast can invert with sun angle and background (and can vanish near thermal crossover).

Acoustics (if audio available or captured concurrently)
- Multirotor drones: Dominated by blade■passing frequency (BPF) and harmonics: BPF = RPM/60 × (number of blades), producing a comb of strong tones plus broadband turbulence noise. In forward flight, tone/broadband balance and directivity change.
- Jets/rockets: Broadband high■level noise without discrete BPF combs; rockets add low■frequency rumble plus high■temp jet■mixing components.

RF / Electronic
- Most consumer/pro drones exchange control/telemetry/video in 2.4/5.8 GHz ISM (and sometimes 900 MHz/433 MHz). Passive RF monitoring often reveals hopping, bandwidth, and vendor■specific fingerprints. Since Remote ID now broadcasts over Bluetooth or Wi■Fi (ASTM F3411 / FAA Part 89), decoding those frames (where legal) can positively identify a small UAS.

2) Quick discrimination guide (what to look for in footage)

Electric quad/hex:
- Visible/NIR: Single white strobe at night (if compliant). No red/green/white nav-light triad required.
- MWIR/LWIR: No hot plume; warm battery/motors; compact hotspot.
- Acoustic: Strong BPF comb + harmonics (hundreds of Hz to low kHz).
- RF: 2.4/5.8 GHz links; often Remote ID BLE/Wi■Fi beacons.
- Kinematics: Agile but physically plausible; hover/stop behavior common.

Manned jet/turboprop:
- Visible/NIR: Red/green/white nav lights + strobes; anti■collision beacon.
- MWIR/LWIR: MWIR■bright exhaust plume (CO■ 4.3 µm), LWIR cooler airframe often dominates.
- Acoustic: Broadband jet/turbine noise; no BPF comb.
- RF: ADS■B (not a propulsion signature but useful).
- Kinematics: Smooth, energy■consistent turns; plausible bank angles.

Rocket:
- Visible/NIR: Luminous plume, shock diamonds.
- MWIR/LWIR: Intense MWIR/LWIR emission; species lines (H■O/CO■).
- Acoustic: Very high broadband levels.
- Kinematics: Strong, monotonic acceleration along thrust axis.

Balloon/lantern:
- Visible/NIR: No nav lights; possible candle flicker (lantern).
- MWIR/LWIR: Cool or mixed (reflective) signature, easily lost near thermal crossover.
- Acoustic: Silent except wind noise.
- Kinematics: Drifts with wind; no rapid accelerations.

3) The big gotchas: artifacts that mimic “propulsion”

1) Parallax from a moving sensor: A slow, wind■drifting target can appear to “dart” when the camera platform turns/zooms. In the GoFast case, apparent speed collapses to ~40 mph (near wind speed) and the target is colder than the ocean.
2) Thermal crossover & loss of contrast (IR): Around sunrise/sunset, background temp crosses the target’s temp, making objects vanish/reappear in IR. Puerto Rico re■analysis attributes “water entry/exit” to contrast loss plus changing range/angle.
3) IR “wakes” that are really sensor trails: Faint streaks in IR can be sensor artifacts; don’t treat as exhaust without independent confirmation.
4) Glare/derotation geometry in targeting pods: In ATFLIR■type pods, image derotation can keep the horizon steady while glare from a hot source rotates—mimicking “self■rotation.”
5) Out■of■focus/bokeh shapes: Triangle/diamond “craft” often defocused lights or known objects. Cross■check focus/aperture before inferring vehicles.

4) A rigorous workflow you can apply to any clip

A — Metadata & environment
- Exact time (UTC), GPS location, sensor type/band (RGB, NIR, MWIR, LWIR), lens FOV, zoom, frame rate, platform motion (IMU if available).
- Pull winds aloft and check for thermal crossover windows near civil twilight.

B — Stabilize & calibrate
- Stabilize; extract per■frame boresight. Calibrate pixel angle (pixels/degree) using FOV. Note derotation behavior for EO/IR pods.

C — Kinematics
- Track centroid; convert pixel motion → angular motion; subtract camera motion. With range cues (display readouts, triangulation, Remote ID geo), convert to true speed/acceleration and compare to plausible limits for size class.

D — Thermal photometry
- For MWIR/LWIR, compare object radiance vs background. No MWIR excess + “cold” against sea → inconsistent with hot plume. MWIR■bright core with trailing structure → jet/rocket. Use dual■band where possible.

E — Photometry of lights
- Extract light curves. Single high■intensity white strobe (~1–2 Hz) without red/green/white positions → small UAS. Unambiguous red■green■white geometry → manned aircraft.

F — Acoustics
- FFT any audio. Look for a BPF comb (multirotor) vs broadband (jet/rocket).

G — RF/Remote ID (respect legal constraints)
- Monitor 900 MHz/2.4/5.8 GHz; look for BLE/Wi■Fi Remote ID beacons for small UAS attribution.

H — Corroboration
- Cross■check ADS■B, NOTAMs, satellite passes, and local events (e.g., sky lantern releases) before positing uncommon propulsion.

5) Case studies worth pattern■matching against

GoFast (2015, USN):
- Proper trigonometry using display data gives ~40 mph average speed (≈ wind), colder than the ocean, no heat plume.

“Atmospheric Wakes” (2022–23):
- Three IR videos thought to show “propulsive wakes” resolved as sensor artifacts; objects likely ordinary aircraft.

Eglin “cone” UAP (2023):
- IR/EO contrast and paneling match large lighting balloons; “blurry heat” likely misperception/tether.

Puerto Rico (2013):
- The famous “splitting/transmedium” video is two small objects (likely sky lanterns) drifting at ~8 mph, with “water entry” explained by thermal crossover and range■driven contrast loss.

6) Practical indicators/checklist you can run on each clip

Signs pointing to non■exotic electric drones
- Single white strobe at night; no red/green/white pattern.
- No MWIR plume; compact warm core (battery/motors).
- Acoustic BPF comb (strong, evenly spaced tones).
- Remote ID packets present (BLE/Wi■Fi).

Signs pointing to jet/rocket propulsion (not multirotor)
- MWIR■dominant, structured plume; sometimes shock■cell pattern.
- No BPF comb in audio; broadband turbine/rocket noise.
- Stable nav■light geometry (red■green■white) at night.

High■risk pitfalls to annotate
- Camera turns/zooms → parallax.
- Thermal crossover near twilight.
- IR sensor trails misread as wakes/exhaust.
- Derotation/glare artifacts in targeting pods.

7) Next step

If you share a representative clip, I can apply this pipeline once to give a propulsion■specific readout (what’s present, what isn’t, and what that implies). Include: time (UTC), location, sensor/band, FOV/zoom/frame rate, platform motion, and whether Remote ID monitoring or concurrent audio was captured.

Notes on sources

This guide synthesizes findings from NASA’s UAP independent study and DoD/AARO public case resolutions; standard EO/IR physics of jet/rocket plumes (MWIR■dominant emissions in CO■/H■O bands); FAA Part 107 night■ops lighting and Remote ID rules; peer■reviewed measurements of small■UAS IR signatures; and drone acoustic characterization showing BPF harmonic structure. Where possible, cross■validate with calibrated multisensor data rather than single■sensor heuristics.