Mass Resonance Identifier (MRI): Cluster-Averaged Detection via Relativistic Bandwidth Weighting

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Abstract

We present a non-destructive field-capable method for identifying atomic clusters using relativistic resonance weighting. Rather than detecting individual atoms, the Mass Resonance Identifier (MRI) system applies Real-Time Fractional Tracking (R-TFT) with adaptive filtering to cluster-averaged resonances, weighted by mass and natural abundance. A golden ratio-stabilized bandwidth scaling ensures optimized detection across varying noise environments.

1. Method Overview

1.1 Core Protocol: Bandwidth-Weighted Cluster Averaging

Let M be a mass range (e.g., 55–57 amu for Fe isotopes). We define the intensity signature:

$$I_{\text{avg}}(M) = \frac{\sum_{k=1}^{N} w_k \cdot \int_{\Delta f_k} R_{\text{clean}}(f) df}{\sum_k w_k} \tag{1}$$

where:

- $w_k = \left(\frac{m_k}{m_0}\right)^{\gamma} \cdot A_k$ — relativistic mass weighting with natural abundance
- $\Delta f_k = \phi \cdot \frac{\Gamma_k}{2\pi}$ — bandwidth scaled by golden ratio (ϕ)
- $R_{\text{clean}}(f)$ — adaptive background-subtracted resonance

1.2 Adaptive Filtering via R-TFT

$$R_{\text{clean}} = 2R_{\text{inner}} - R_{\text{outer}} \tag{2}$$

ensuring resilience in chaotic or noisy conditions.

2. System Components

Component	Function	Integration
Excitation Coil	ϕ-tuned RF pulses	$f = \phi \cdot f_{\text{target}}$
Receiver Array	Captures decay signal	Multi-vector R-TFT projection
RME Module	Cluster library matching	Cosine similarity in feature space

3. Use Cases

- **Alloy Detection**: Cu-Zn, Fe-Ni via mass clustering
- **Landmine Identification**: via Fe-based signature in presence of soil
- **Recycling**: Rare-earth separation (Nd, Dy)

4. Advantages

- **Non-destructive**: Unlike MS or XRF
- **Field-compatible**: No cryogens
- **Isotope-aware**: Tunable γ

5. Ethical Constraints

Governed under REL-1.0. Forbidden use in surveillance, military, or nuclear profiling.
License: https://github.com/qcfrag/Real-Time-Fractional-Tracking-R-TFT/blob/main/LICENSE.txt