A nuclear norm regularized estimator

For each of the n query vectors $\mathbf{a}_i$:

- **Bias elimination:** Collect m PAQ responses $\gamma_{i_1}, \ldots, \gamma_{i_m}$ and form *averaged response* $\bar{\gamma}_i^2 = \frac{1}{m}\sum_{j=1}^{m} \gamma_{i_j}^2$
- **Heavy-tail mitigation:** Truncate the averaged response by some value τ. Form *shrunken response* $\tilde{\gamma}_i^2 = \min\{\bar{\gamma}_i^2, \tau\}$
- Form *shrunken sensing matrix* $\widetilde{\mathbf{A}}_i = \tilde{\gamma}_i^2 \mathbf{a_i} \mathbf{a_i}^\top$

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- Estimate $\mathbf{M}$ using the shrunken sensing matrices + nuclear norm regularizer

$$\widehat{\mathbf{M}} = \arg\min_{\mathbf{M} \succeq \mathbf{0}} \quad \frac{1}{n} \sum_{i=1}^{n} \left(y - \langle \widetilde{\mathbf{A}}_i, \mathbf{M} \rangle \right)^2 + \lambda_n \|\mathbf{M}\|_*$$

Apply averaging and truncation to sensing matrices!

- In all, collect $N = mn$ total measurements, but utilize the n effective measurements