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*Bounds for the Hilbert Transform with Matrix Muckenhoupt Weights.*

Let  $W$  denote a matrix  $A_2$  weight. In this talk we will implement the scalar proof for the square function to deduce related results for vector-valued functions on  $L^2(\mathbb{R}, \mathbb{C}^d)$ . These results are then used to study the boundedness of the Hilbert transform and Haar multipliers on  $L^2(\mathbb{R}, \mathbb{C}^d)$ . In particular, we prove that:

$$\begin{aligned}\|Hf\|_{L^2(W)} &\lesssim [W]_{A_2}^{\frac{3}{2}} \log [W]_{A_2} \|f\|_{L^2(W)} \\ \|T_\sigma f\|_{L^2(W)} &\lesssim [W]_{A_2}^{\frac{3}{2}} \log [W]_{A_2} \|\sigma\|_\infty \|f\|_{L^2(W)}.\end{aligned}$$

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