



JOHANNES GUTENBERG
UNIVERSITÄT MAINZ



Hadronic Structure Effects in PVES @ P2

Institute for Nuclear Physics

Rolando Martinez

CRC 1660 Kick-Off

December 2024



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**B02: Standard Model precision tests with
hadrons and nuclei**

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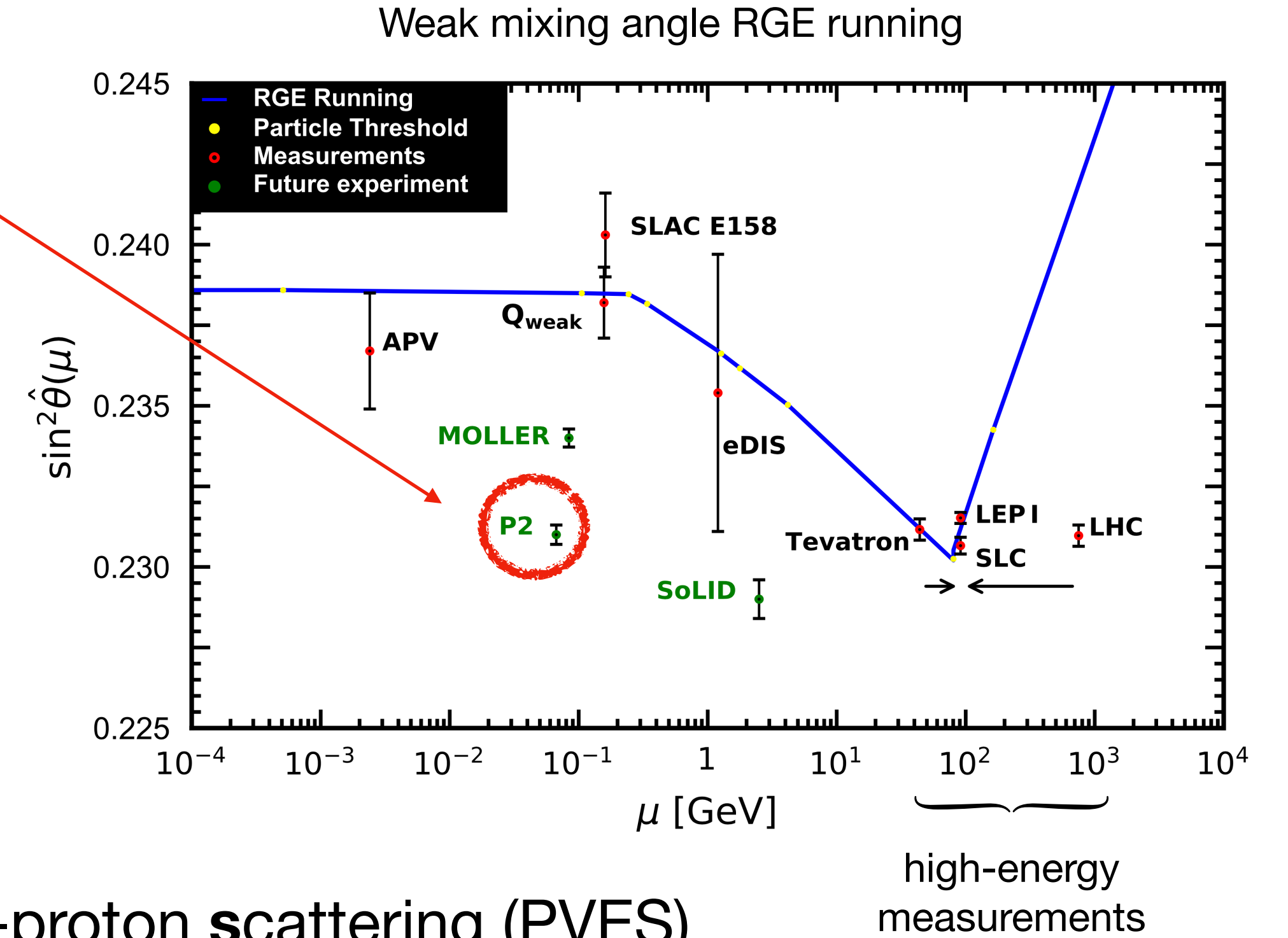
December 2024

P2 Experiment in MESA Accelerator

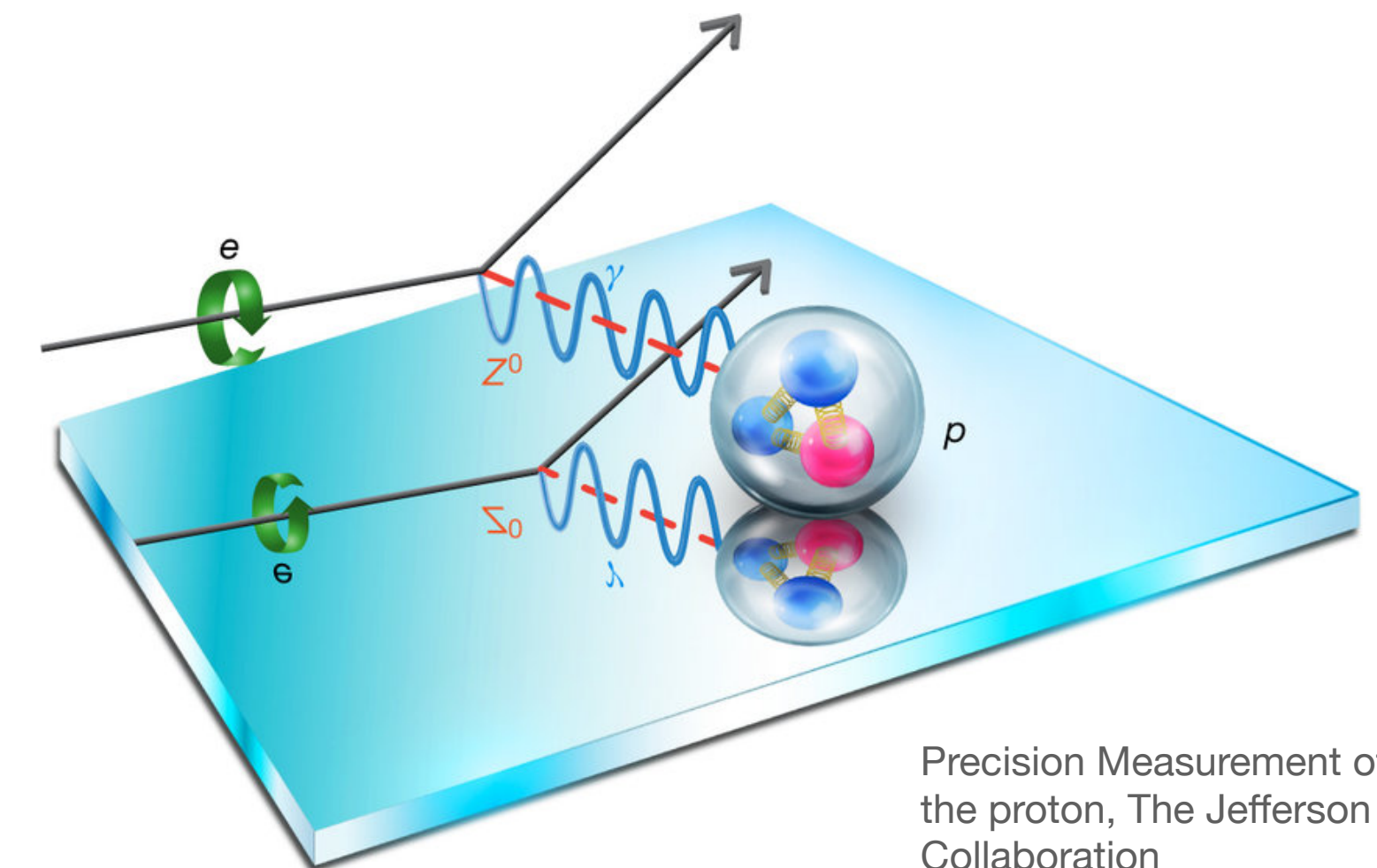
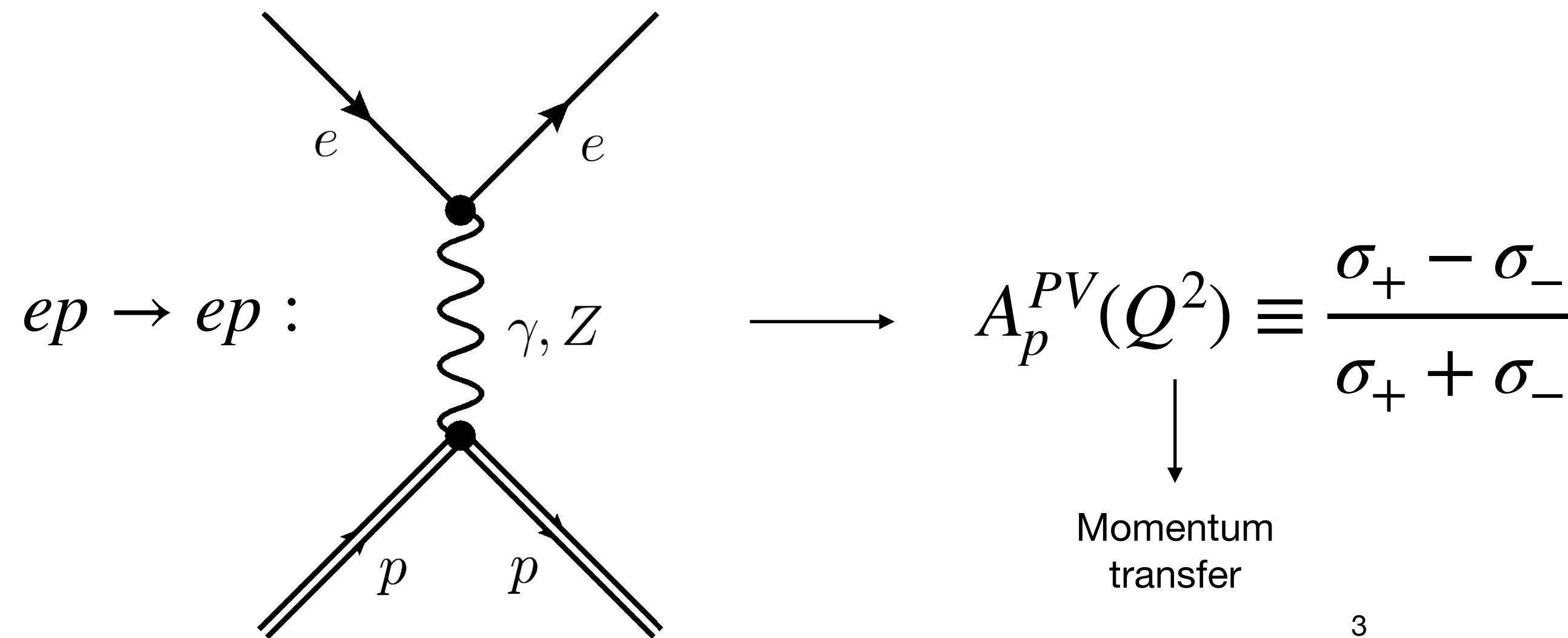
- **The goal:** Clear determination of $\sin^2 \theta_W$ at low-energies, measuring the proton's weak charge Q_W^p

$$Q_W^p = (1 - 4 \sin^2 \theta_W) \longrightarrow \text{SM Precision Test}$$

Tree level



- **The observable:** Parity-violating asymmetry in elastic electron-proton scattering (PVES)



Precision Measurement of weak charge of the proton, The Jefferson Lab Qweak Collaboration

Form Factors in PVES

- The proton's inner structure plays a role in the asymmetry:

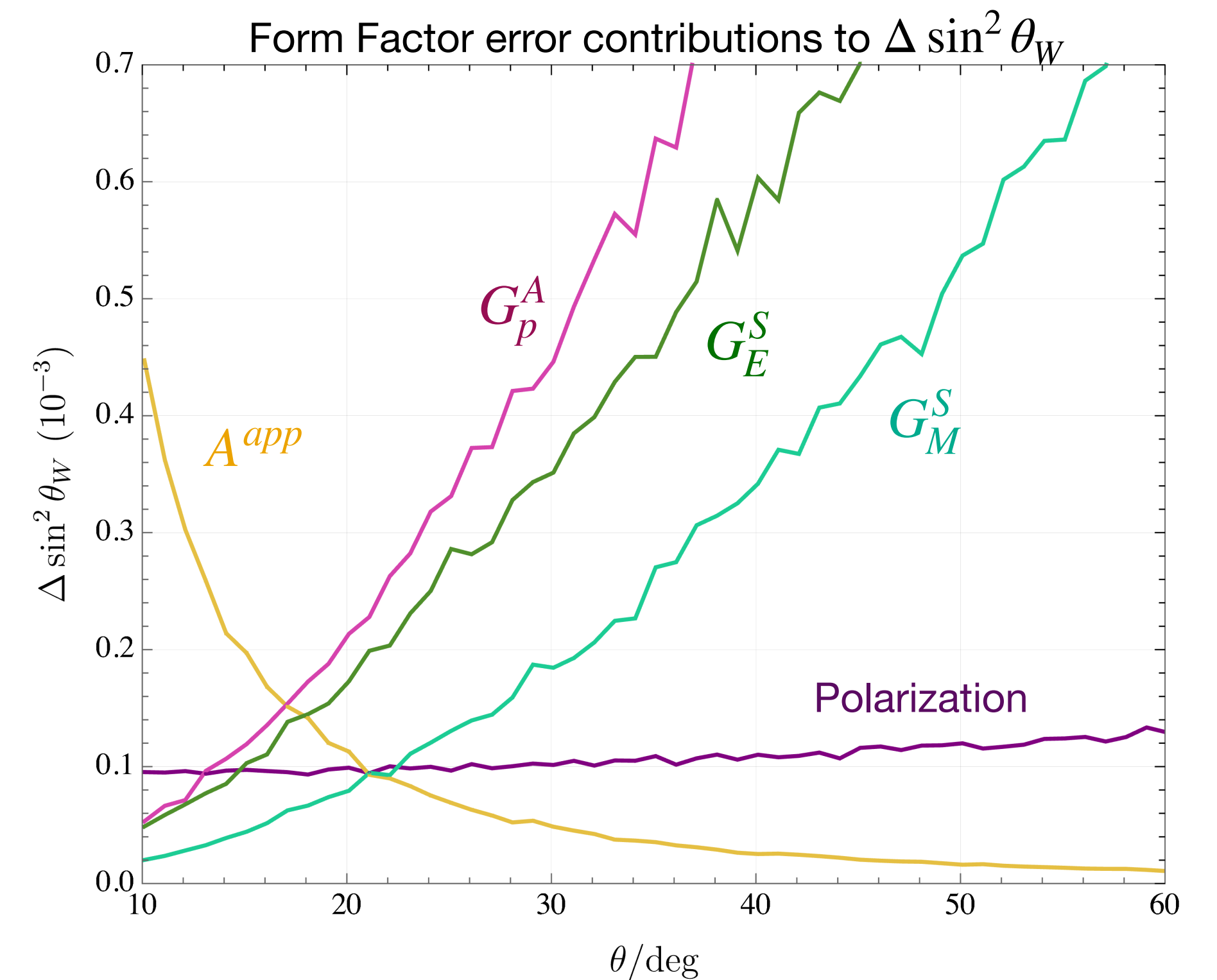
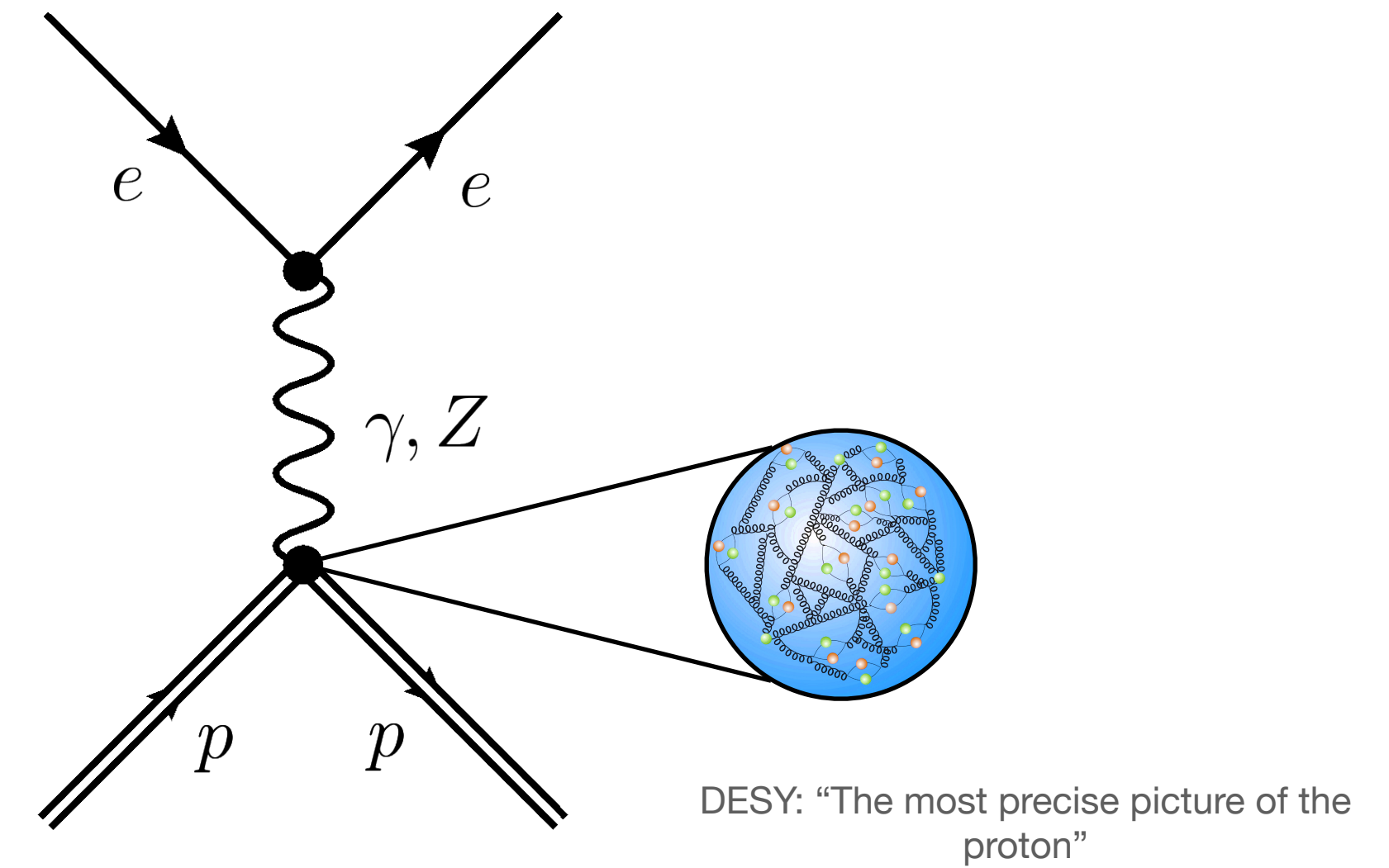
$$A_p^{PV} = -\frac{G_F}{4\sqrt{2}\pi\alpha} Q^2 \left[Q_W^p - F(Q^2) \right]$$

Form factors: Encode contributions from the hadronic structure of the nucleon

- At low Q^2 , A_p^{PV} is dominated by Q_W^p :

$$F(Q^2 \rightarrow 0) \rightarrow 0$$

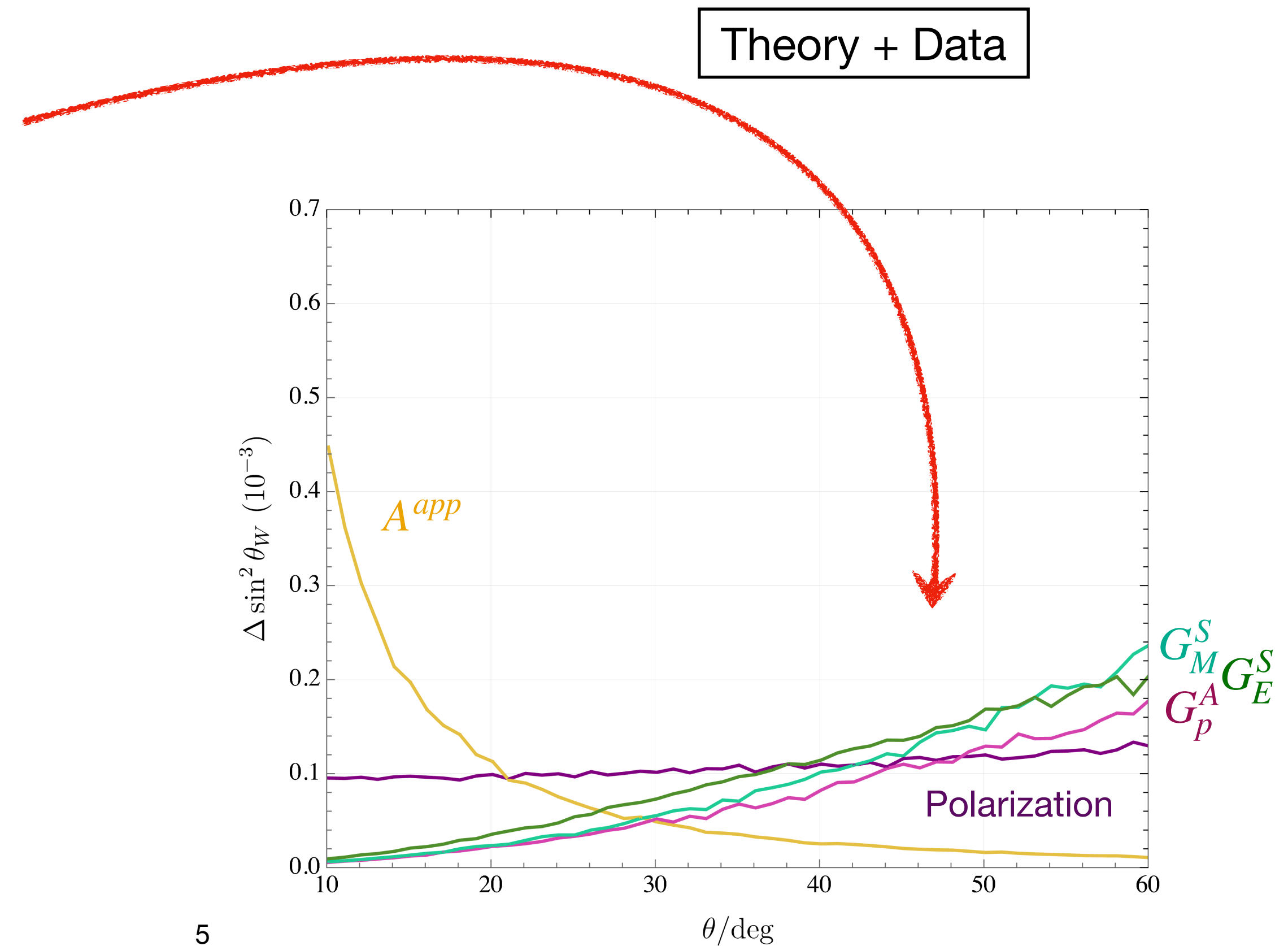
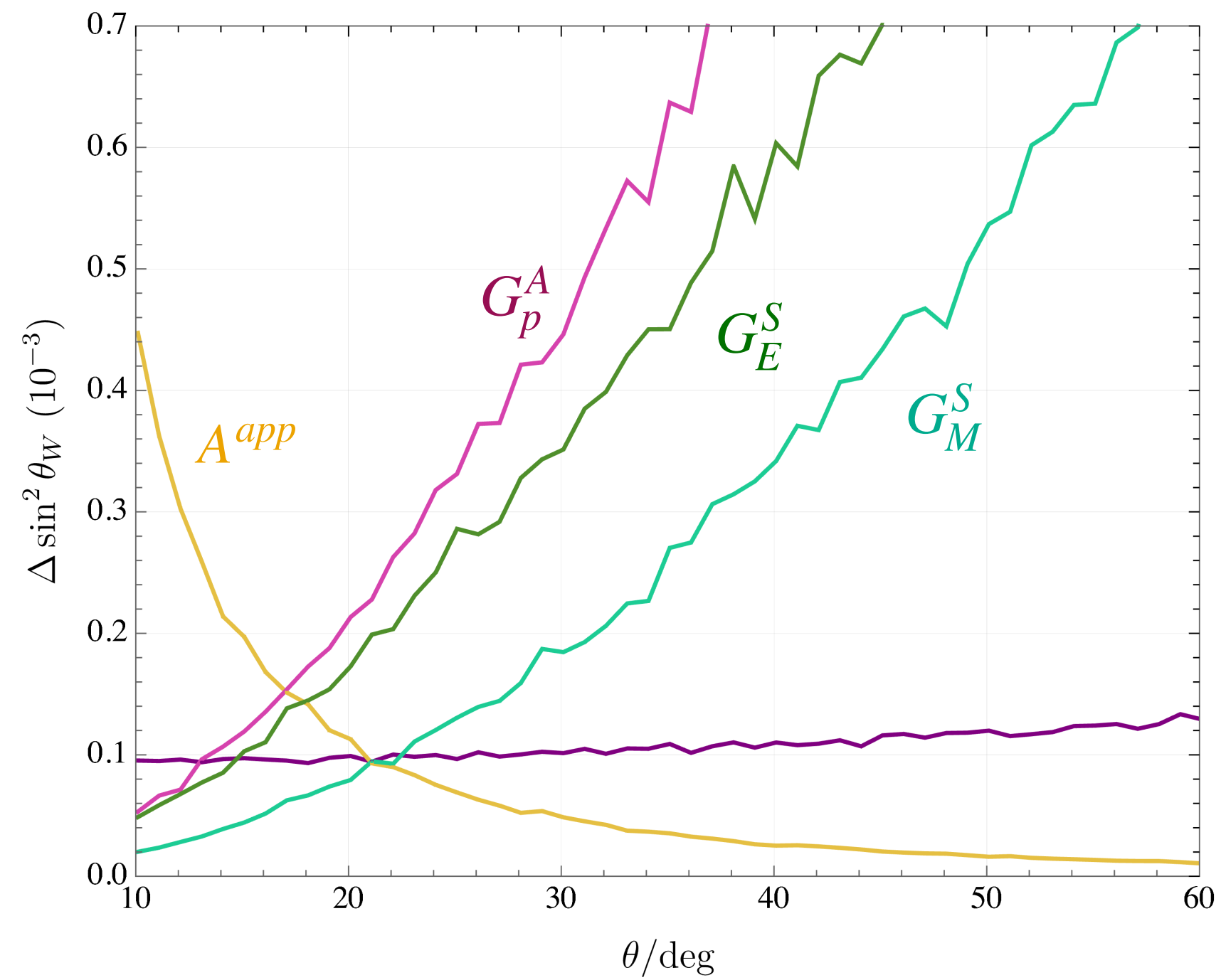
- ...but Form Factor effects have to be considered to achieve the desirable precision



Questions to answer:

How do the Form Factor contributions affect the Q_W^p measurement?

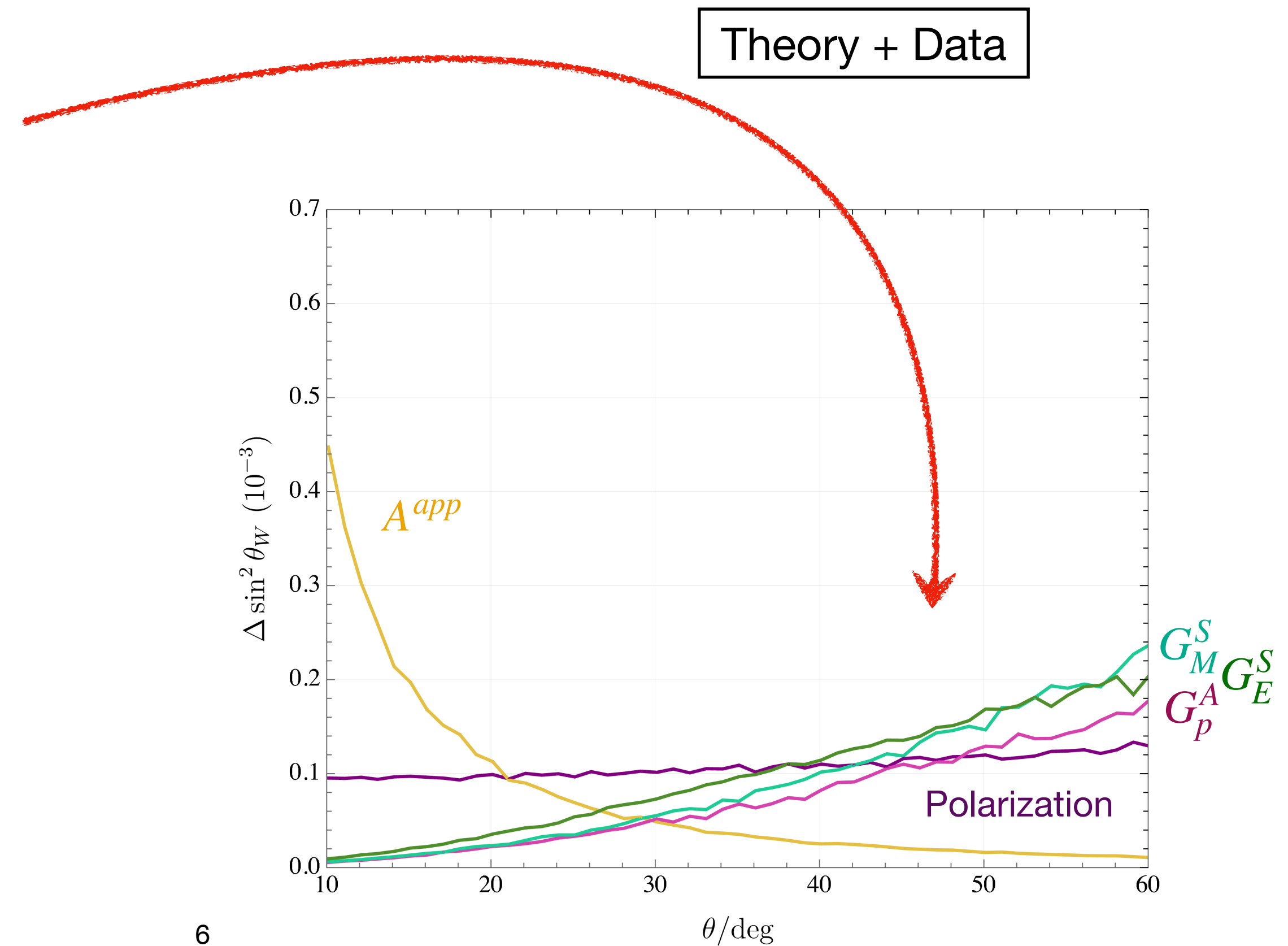
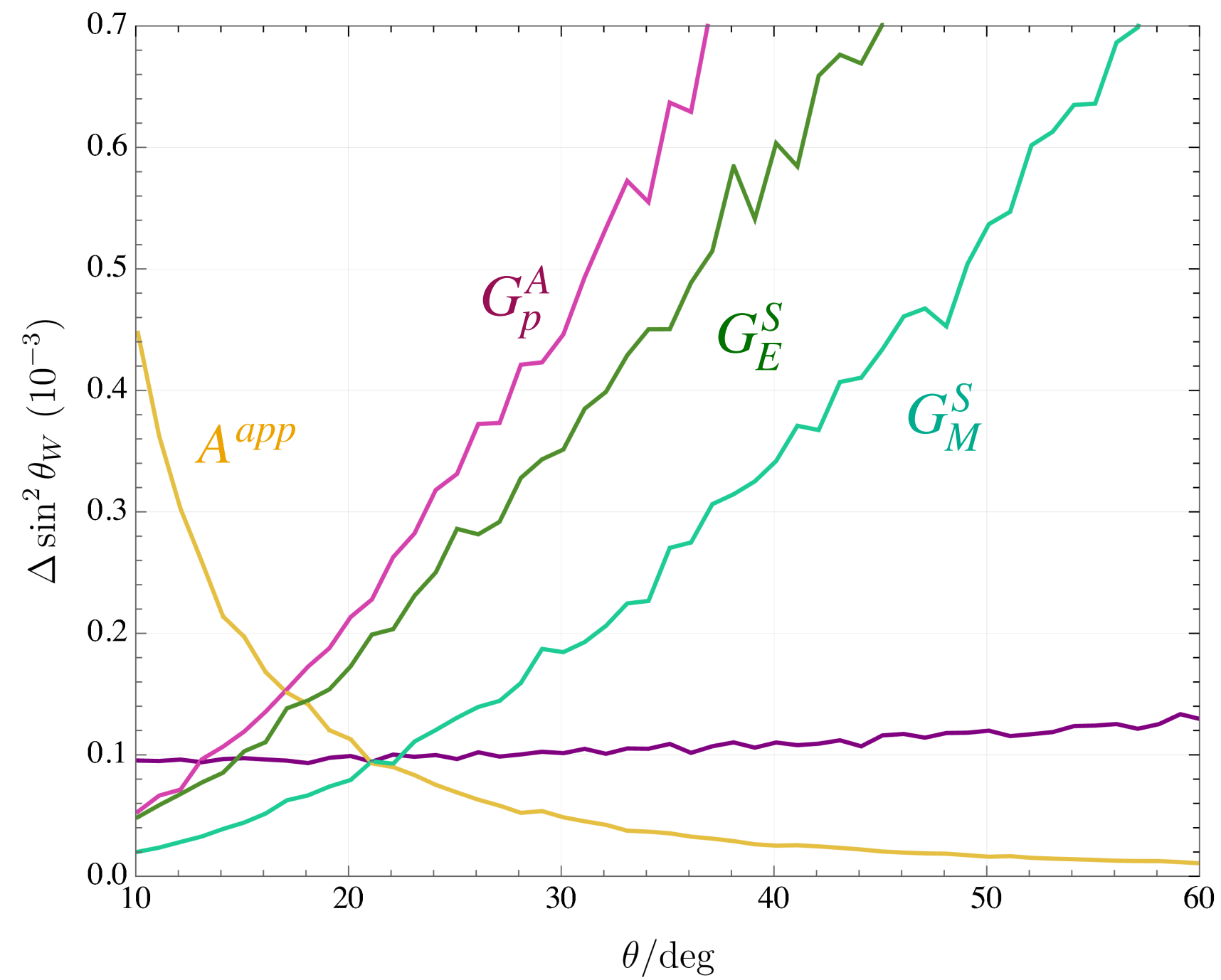
How can we quantify and minimize uncertainties?



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Thanks!