







































I sat



I ref

$$\sqrt{\frac{(\sigma_{sat} \cdot I_{ref})^2 + (\sigma_{ref} \cdot I_{sat})^2}{I_{ref}}}$$



$$\frac{(R_i - R_i(\theta))^2}{\sigma_i^2}$$







40



4π



$$(\gamma_H \gamma_X \hbar)^2$$

$$(\tau^6)$$

$$(\omega_X \Delta \sigma)^2$$

$$3$$





$$\sigma_{\text{NOE}}(\theta)$$

$$R_1(\theta)$$



h



h = h



$$s^2$$



$$1 + (\omega \tau_i)^2$$

$$\frac{(1 - S^2)(\tau_e + \tau_i)\tau_e}{(\tau_e + \tau_i)^2 + (\omega\tau_e\tau_i)^2}$$















$$2Q_r)(\delta_x^4 + 2\delta_y^2\delta_z^2) + (1 - 3Q_r)(\delta_y^4 + 2\delta_x^2\delta_z^2) - 2(\delta_z^4 + 2\delta_x^2\delta_y^2) \Big],$$

$$202 + 1 = 203$$









$$\begin{pmatrix} 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & -1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & -1 & 0 & 0 & 0 & 0 & 0 & 0 \\ 1 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 1 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & -1 & 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & -1 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & -1 \end{pmatrix}$$

S^2

S^2_f

S^2_s

T_e

T_f

T_s

Rex

r

CSA



$$\begin{pmatrix} 0 \\ -1 \\ 0 \\ -1 \\ 0 \\ -1 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0.9e^{-10} \\ 2e^{-10} \\ 300e^{-6} \\ 0 \end{pmatrix}$$



$$\begin{pmatrix} -1 & 0 & 0 \\ 0 & -1 & 0 \\ 0 & 0 & -1 \end{pmatrix}$$

τ_e τ_f τ_g

$$\begin{pmatrix} -2\tau m \\ -2\tau m \\ -2\tau m \end{pmatrix}$$

$$\begin{pmatrix} 2 & -1 & 0 & 0 \\ 2 & 0 & -1 & 0 \\ 2 & 0 & 0 & -1 \end{pmatrix}$$

τ_m

τ_e

τ_f

τ_s



$$\begin{pmatrix} 1 & 0 & 0 \\ -1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \\ 0 & 0 & -1 \end{pmatrix}$$

$$\begin{pmatrix} T_m \\ \mathcal{D}_a \\ \mathcal{D}_r \end{pmatrix}$$

$$\begin{pmatrix} 0 \\ -200.0e^{-9} \\ 0 \\ 0 \\ -1 \end{pmatrix}$$



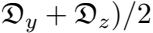


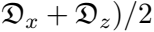


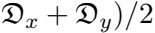


$$\begin{pmatrix} 1e^{-12} & 0 & 0 & 0 & 0 & 0 \\ 0 & 1e^7 & 0 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 0 & 1 \end{pmatrix}$$

$$\begin{pmatrix} 1e^{-12} & 0 & 0 & 0 \\ 0 & 1e^7 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{pmatrix}$$

















$$G : \min_{\theta \in \mathcal{U}} \Delta_{K-L}(\theta)$$









U



$\sum_i \text{NOE}^2$





$$M_A(t)$$

$$M_B(t)$$





$$-i\Omega_A - R_{2A}^0 - p_B k_{ex}$$

$$p_B k_{ex}$$

$$p_A k_{ex}$$

$$-i\Omega_B - R_{2B}^0 - p_A k_{ex}$$









$$\sqrt{\omega^2} + \omega_1^2$$









1



Relax



$$I_1(\nu_{\text{CPMG}})$$

$$I_0$$





$$I_1(\omega_1)$$

$$I_0$$



$$\sqrt{\left(\frac{\sigma_{I_1}}{I_1(\omega_1)}\right)^2 + \left(\frac{\sigma_{I_0}}{I_0}\right)^2}$$



11

10















QA



A





50



50





011



11



$$\sigma_{I_1}$$

$$I_{\text{relax } I_1}(\omega_1)$$











$$\Phi_{ex,i}$$

$$k_i$$



41/CPMG

k_i



k_i



4vCPMG







ex



lex

ex



41/CPMG

k_{ex}



k_{ex}



$4\nu_{CPMG}$





3



2













$$\frac{\Psi + 2\Delta\omega^2}{\sqrt{\Psi^2 + \zeta^2}}$$





1



VCPMG



A pixelated, black and white representation of the mathematical expression $\sqrt{\Psi^2 + \Phi^2}$. The equation is rendered in a low-resolution, dithered style. It features a large square root symbol on the left, followed by the Greek letter Psi (Ψ) squared, a plus sign, the Greek letter Phi (Φ) squared, and a closing square root symbol on the right. A horizontal line extends from the top of the square root symbol across the top of the image.













$$\Phi_{ex} \tau_{ex}$$

$$1 + \omega_a^2 \tau_{ex}^2$$

$$\sqrt{v_{1\text{eff}}^4 + p_A^2 \Delta v^4}$$



$$\frac{\sin(\Delta\omega \cdot \tau_{\text{CPMG}})}{\Delta\omega \cdot \tau_{\text{CPMG}}}$$











$$\sqrt{v_1^2 - 1}$$













$$\frac{m_D + + m_Z +}{2}$$

$$\sqrt{\frac{P_B}{P_A}}$$



$$2k_{ex} \sqrt{p_A p_B}$$

$$d_{\pm} z_{\pm}$$



$$\sin(z \pm \delta)$$

$$\sin(d_{\pm} + z_{\pm})\delta$$







$$\sin(d_{\pm})$$

$$\sin(d_{\pm} + z_{\pm})$$











1



4 1/2 CPMG

$$M_A(T_{\text{relax}})$$

$$M_A(0)$$





$$\begin{pmatrix} -k_{AB} - R_{2A}^0 & k_{BA} \\ k_{AB} & -k_{BA} \pm 2\Delta\omega - R_{2B}^0 \end{pmatrix}$$







0.5



PA

10











$$\begin{pmatrix} -\kappa_{AB} & \kappa_{BA} & 0 \\ \kappa_{AB} & -\kappa_{BA} - \kappa_{BC} \pm i\Delta\omega_{AB} & \kappa_{CB} \\ 0 & \kappa_{BC} & -\kappa_{CB} \pm i\Delta\omega_{AC} \end{pmatrix}$$

$$\begin{pmatrix} R_{2A}^0 & 0 & 0 \\ 0 & R_{2B}^0 & 0 \\ 0 & 0 & R_{2C}^0 \end{pmatrix}$$





1

0

0

p_A

p_B

p_C





$$\begin{pmatrix} -k_{AB} - k_{AC} & k_{BA} & k_{CA} \\ k_{AB} & -k_{BA} - k_{BC} \pm i\Delta\omega_{AB} & k_{CB} \\ k_{AC} & k_{BC} & -k_{CB} - k_{CA} \pm i\Delta\omega_{AC} \end{pmatrix}$$

$$\Phi_{ex} k_{ex}$$

$$k_{ex}^2 + \omega_e^2$$

$$p_A^2 p_B \Delta \omega^2 k_{ex}$$

$$k_{ex}^2 + p_A^2 \Delta \omega^2 + \omega_1^2$$





$$\sin^2\theta p_A p_B \Delta\omega^2 k_{ex}$$

$$\omega_{Aeff}^2 \omega_{Beff}^2 / \omega_{eff}^2 + k_{ex}^2$$







$$\sin^2 \hat{\theta} p_A p_B \Delta \omega^2 k_{\text{ex}}$$

$$\omega_{\text{Aeff}}^2 \omega_{\text{Beff}}^2 / \omega_{\text{eff}}^2 + k_{\text{ex}}^2 - 2 \sin^2 \hat{\theta} p_A p_B \Delta \omega^2 + (1 - \gamma) \omega_1^2$$

$$\sin^2 \theta p_A p_B \Delta \omega^2 k_{\text{ex}}$$

$$\omega_{\text{Aeff}}^2 \omega_{\text{Beff}}^2 / \omega_{\text{eff}}^2 + k_{\text{ex}}^2 - \sin^2 \theta p_A p_B \Delta \omega^2 \left(1 + \frac{2k_{\text{ex}}^2 (p_A \omega_{\text{Aeff}}^2 + p_B \omega_{\text{Beff}}^2)}{\omega_{\text{Aeff}}^2 \omega_{\text{Beff}}^2 + \omega_{\text{eff}}^2 k_{\text{ex}}^2} \right)$$





$$\begin{pmatrix} \sin \theta \\ 0 \\ \cos \theta \\ 0 \\ 0 \\ 0 \end{pmatrix}$$



w1



Ω A



$$\begin{pmatrix} -R'_{1\rho} - k_{AB} & -\delta_A & 0 & k_{BA} & 0 & 0 \\ \delta_A & -R'_{1\rho} - k_{AB} & -\omega_1 & 0 & k_{BA} & 0 \\ 0 & \omega_1 & -R_1 - k_{AB} & 0 & 0 & k_{BA} \\ k_{AB} & 0 & 0 & -R'_{1\rho} - k_{BA} & -\delta_B & 0 \\ 0 & k_{AB} & 0 & \delta_B & -R'_{1\rho} - k_{BA} & -\omega_1 \\ 0 & 0 & k_{AB} & 0 & \omega_1 & -R_1 - k_{BA} \end{pmatrix}$$

$$\begin{pmatrix} \sin \theta \\ 0 \\ \cos \theta \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \end{pmatrix}$$

$$\begin{pmatrix} -R'_{1\rho A} - k_{AB} - k_{AC} & -\delta_A & 0 & \cdots \\ \delta_A & -R'_{1\rho A} - k_{AB} - k_{AC} & -\omega_1 & \cdots \\ 0 & \omega_1 & -R_{1A} - k_{AB} - k_{AC} & \cdots \\ \vdots & \vdots & \vdots & \ddots \end{pmatrix}$$

$$\begin{pmatrix} \cdot & \cdot & \cdot & \vdots & \vdots & \vdots & \cdot & \cdot & \cdot \\ \cdot & \cdot & \cdot & -R'_{1\rho B} - k_{BA} - k_{BC} & -\delta_B & 0 & \cdot & \cdot & \cdot \\ \cdot & \cdot & \cdot & \delta_B & -R'_{1\rho B} - k_{BA} - k_{BC} & -\omega_1 & \cdot & \cdot & \cdot \\ \cdot & \cdot & \cdot & 0 & \omega_1 & -R_{1B} - k_{BA} - k_{BC} & \cdot & \cdot & \cdot \\ \cdot & \cdot & \cdot & \vdots & \vdots & \vdots & \cdot & \cdot & \cdot \\ \cdot & \cdot & \cdot & \vdots & \vdots & \vdots & \cdot & \cdot & \cdot \end{pmatrix}$$

$$\begin{pmatrix} \cdot & \cdot & \cdot & \vdots & \cdot & \vdots & \cdot \\ \cdot & \cdot & \cdot & -R'_{1\rho C} - k_{CA} - k_{CB} & -\delta_C & 0 \\ \cdot & \cdot & \cdot & \delta_C & -R'_{1\rho C} - k_{CA} - k_{CB} & -\omega_1 \\ \cdot & \cdot & \cdot & 0 & \omega_1 & -R_{1C} - k_{CA} - k_{CB} \end{pmatrix}$$

$$\begin{pmatrix} & & & k_{BA} & 0 & 0 & \dots \\ & \ddots & & 0 & k_{BA} & 0 & \dots \\ & & & 0 & 0 & k_{BA} & \dots \\ k_{AB} & 0 & 0 & & & & \\ 0 & k_{AB} & 0 & & \ddots & & \dots \\ 0 & 0 & k_{AB} & & & & \\ \vdots & \vdots & \vdots & & \vdots & & \ddots \end{pmatrix}$$

$$\begin{pmatrix} & & & \cdots & k_{CA} & 0 & 0 \\ & \ddots & & \cdots & 0 & k_{CA} & 0 \\ & & & \cdots & 0 & 0 & k_{CA} \\ \vdots & \vdots & \vdots & \ddots & \vdots & \vdots & \vdots \\ k_{AC} & 0 & 0 & \cdots & & & \\ 0 & k_{AC} & 0 & \cdots & & \ddots & \\ 0 & 0 & k_{AC} & \cdots & & & \end{pmatrix}$$

$$\begin{pmatrix} \ddots & & & & & & \\ & \ddots & & & & & \\ & & \ddots & & & & \\ & & & \ddots & & & \\ & & & & \ddots & & \\ & & & & & \ddots & \\ & & & & & & \ddots \end{pmatrix} \begin{pmatrix} \vdots & & & & & & \\ & \vdots & & & & & \\ & & \vdots & & & & \\ & & & \vdots & & & \\ & & & & \vdots & & \\ & & & & & \vdots & \\ & & & & & & \vdots \end{pmatrix} \begin{pmatrix} k_{CB} & 0 & 0 \\ 0 & k_{CB} & 0 \\ 0 & 0 & k_{CB} \\ k_{BC} & 0 & 0 \\ 0 & k_{BC} & 0 \\ 0 & 0 & k_{BC} \end{pmatrix} \begin{pmatrix} \ddots & & & & & & \\ & \ddots & & & & & \\ & & \ddots & & & & \\ & & & \ddots & & & \\ & & & & \ddots & & \\ & & & & & \ddots & \\ & & & & & & \ddots \end{pmatrix}$$

$$\begin{pmatrix} -R'_{1\rho A} - k_{AB} & -\delta_A & 0 & \cdots \\ \delta_A & -R'_{1\rho A} - k_{AB} & -\omega_1 & \cdots \\ 0 & \omega_1 & -R_{1A} - k_{AB} & \cdots \\ \vdots & \vdots & \vdots & \ddots \end{pmatrix}$$

$$\begin{pmatrix} \cdot & \cdot & \cdot & \vdots & \vdots & \vdots \\ \cdot & \cdot & \cdot & -R'_{1\rho C} - k_{CB} & -\delta_C & 0 \\ \cdot & \cdot & \cdot & \delta_C & -R'_{1\rho C} - k_{CB} & -\omega_1 \\ \cdot & \cdot & \cdot & 0 & \omega_1 & -R_{1C} - k_{CB} \end{pmatrix}$$

$$\frac{(R_{2\text{eff}} - R_{2\text{eff}}(\theta))^2}{\sigma_i^2}$$

R_2^0 R_{2A}^0 R_{2B}^0

$$\begin{pmatrix} 0 \\ -200 \\ 0 \\ -200 \\ 0 \\ -200 \end{pmatrix}$$

$$\Phi_{\text{ex}}$$

$$\Phi_{\text{ex,B}}$$

$$\Phi_{\text{ex,C}}$$

$$p_A \Delta \omega^2$$

$$\Delta \omega$$

$$\Delta \omega_{\text{AB}}$$

$$\Delta \omega_{\text{BC}}$$

$$\Delta \omega^{\text{H}}$$

$$\Delta \omega_{\text{AB}}^{\text{H}}$$

$$\Delta \omega_{\text{BC}}^{\text{H}}$$



$$\begin{pmatrix} -1 & 0 \\ 1 & 0 \\ 1 & 0 \\ -1 & -1 \\ 1 & 2 \end{pmatrix}$$



$$\begin{pmatrix} -1 \\ 0.5 \\ 0.85 \\ -1 \\ 1 \end{pmatrix}$$

k_{ex} k_{AB}^{ex} k_{BC}^{ex} k_B k_C k_{AB} τ_{ex}

$$\begin{pmatrix}
 0 \\
 -2e^6 \\
 0 \\
 -2e^6 \\
 0 \\
 -2e^6 \\
 0 \\
 -2e^6 \\
 0 \\
 -100 \\
 0
 \end{pmatrix}$$

[illegible]





$$\begin{bmatrix} \delta_x^2 & \delta_x \delta_y & \delta_x \delta_z \\ \delta_y \delta_x & \delta_y^2 & \delta_y \delta_z \\ \delta_z \delta_x & \delta_z \delta_y & \delta_z^2 \end{bmatrix}$$



$$\begin{bmatrix} S_{xx}(\infty) & S_{xy}(\infty) & S_{xz}(\infty) \\ S_{yx}(\infty) & S_{yy}(\infty) & S_{yz}(\infty) \\ S_{zx}(\infty) & S_{zy}(\infty) & S_{zz}(\infty) \end{bmatrix}$$

$$\begin{bmatrix} C_{xx} & C_{xy} & C_{xz} \\ C_{yx} & C_{yy} & C_{yz} \\ C_{zx} & C_{zy} & C_{zz} \end{bmatrix}$$

$$\begin{bmatrix} \delta_{xx} & \delta_{xy} & \delta_{xz} \\ \delta_{yx} & \delta_{yy} & \delta_{yz} \\ \delta_{zx} & \delta_{zy} & \delta_{zz} \end{bmatrix}$$

RESEARCH

$$\begin{bmatrix} \delta_{xx}^2 & \delta_{xx}\delta_{xy} & \delta_{xx}\delta_{xz} & \delta_{xy}\delta_{xx} & \delta_{xy}^2 & \delta_{xy}\delta_{xz} & \delta_{xz}\delta_{xx} & \delta_{xz}\delta_{xy} & \delta_{xz}^2 \\ \delta_{xx}\delta_{yx} & \delta_{xx}\delta_{yy} & \delta_{xx}\delta_{yz} & \delta_{xy}\delta_{yx} & \delta_{xy}\delta_{yy} & \delta_{xy}\delta_{yz} & \delta_{xz}\delta_{yx} & \delta_{xz}\delta_{yy} & \delta_{xz}\delta_{yz} \\ \delta_{xx}\delta_{zx} & \delta_{xx}\delta_{zy} & \delta_{xx}\delta_{zz} & \delta_{xy}\delta_{zx} & \delta_{xy}\delta_{zy} & \delta_{xy}\delta_{zz} & \delta_{xz}\delta_{zx} & \delta_{xz}\delta_{zy} & \delta_{xz}\delta_{zz} \\ \hline \delta_{yx}\delta_{xx} & \delta_{yx}\delta_{xy} & \delta_{yx}\delta_{xz} & \delta_{yy}\delta_{xx} & \delta_{yy}\delta_{xy} & \delta_{yy}\delta_{xz} & \delta_{yz}\delta_{xx} & \delta_{yz}\delta_{xy} & \delta_{yz}\delta_{xz} \\ \delta_{yx}^2 & \delta_{yx}\delta_{yy} & \delta_{yx}\delta_{yz} & \delta_{yy}\delta_{yx} & \delta_{yy}^2 & \delta_{yy}\delta_{yz} & \delta_{yz}\delta_{yx} & \delta_{yz}\delta_{yy} & \delta_{yz}^2 \\ \delta_{yx}\delta_{zx} & \delta_{yx}\delta_{zy} & \delta_{yx}\delta_{zz} & \delta_{yy}\delta_{zx} & \delta_{yy}\delta_{zy} & \delta_{yy}\delta_{zz} & \delta_{yz}\delta_{zx} & \delta_{yz}\delta_{zy} & \delta_{yz}\delta_{zz} \\ \hline \delta_{zx}\delta_{xx} & \delta_{zx}\delta_{xy} & \delta_{zx}\delta_{xz} & \delta_{zy}\delta_{xx} & \delta_{zy}\delta_{xy} & \delta_{zy}\delta_{xz} & \delta_{zz}\delta_{xx} & \delta_{zz}\delta_{xy} & \delta_{zz}\delta_{xz} \\ \delta_{zx}\delta_{yx} & \delta_{zx}\delta_{yy} & \delta_{zx}\delta_{yz} & \delta_{zy}\delta_{yx} & \delta_{zy}\delta_{yy} & \delta_{zy}\delta_{yz} & \delta_{zz}\delta_{yx} & \delta_{zz}\delta_{yy} & \delta_{zz}\delta_{yz} \\ \delta_{zx}^2 & \delta_{zx}\delta_{zy} & \delta_{zx}\delta_{zz} & \delta_{zy}\delta_{zx} & \delta_{zy}^2 & \delta_{zy}\delta_{zz} & \delta_{zz}\delta_{zx} & \delta_{zz}\delta_{zy} & \delta_{zz}^2 \end{bmatrix}$$





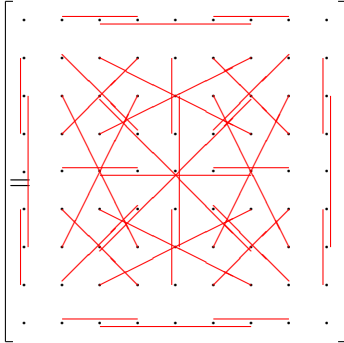
$$\begin{bmatrix}
 \delta_{xx}^2 & \delta_{yx}\delta_{xx} & \delta_{zx}\delta_{xx} & \delta_{xy}\delta_{xx} & \delta_{yy}\delta_{xx} & \delta_{zy}\delta_{xx} & \delta_{xz}\delta_{xx} & \delta_{yz}\delta_{xx} & \delta_{zz}\delta_{xx} \\
 \delta_{xx}\delta_{yx} & \delta_{yx}^2 & \delta_{zx}\delta_{yx} & \delta_{xy}\delta_{yx} & \delta_{yy}\delta_{yx} & \delta_{zy}\delta_{yx} & \delta_{xz}\delta_{yx} & \delta_{yz}\delta_{yx} & \delta_{zz}\delta_{yx} \\
 \delta_{xx}\delta_{zx} & \delta_{yx}\delta_{zx} & \delta_{zx}^2 & \delta_{xy}\delta_{zx} & \delta_{yy}\delta_{zx} & \delta_{zy}\delta_{zx} & \delta_{xz}\delta_{zx} & \delta_{yz}\delta_{zx} & \delta_{zz}\delta_{zx} \\
 \hline
 \delta_{xx}\delta_{xy} & \delta_{yx}\delta_{xy} & \delta_{zx}\delta_{xy} & \delta_{xy}^2 & \delta_{yy}\delta_{xy} & \delta_{zy}\delta_{xy} & \delta_{xz}\delta_{xy} & \delta_{yz}\delta_{xy} & \delta_{zz}\delta_{xy} \\
 \delta_{xx}\delta_{yy} & \delta_{yx}\delta_{yy} & \delta_{zx}\delta_{yy} & \delta_{xy}\delta_{yy} & \delta_{yy}^2 & \delta_{zy}\delta_{yy} & \delta_{xz}\delta_{yy} & \delta_{yz}\delta_{yy} & \delta_{zz}\delta_{yy} \\
 \delta_{xx}\delta_{zy} & \delta_{yx}\delta_{zy} & \delta_{zx}\delta_{zy} & \delta_{xy}\delta_{zy} & \delta_{yy}\delta_{zy} & \delta_{zy}^2 & \delta_{xz}\delta_{zy} & \delta_{yz}\delta_{zy} & \delta_{zz}\delta_{zy} \\
 \hline
 \delta_{xx}\delta_{xz} & \delta_{yx}\delta_{xz} & \delta_{zx}\delta_{xz} & \delta_{xy}\delta_{xz} & \delta_{yy}\delta_{xz} & \delta_{zy}\delta_{xz} & \delta_{xz}^2 & \delta_{yz}\delta_{xz} & \delta_{zz}\delta_{xz} \\
 \delta_{xx}\delta_{yz} & \delta_{yx}\delta_{yz} & \delta_{zx}\delta_{yz} & \delta_{xy}\delta_{yz} & \delta_{yy}\delta_{yz} & \delta_{zy}\delta_{yz} & \delta_{xz}\delta_{yz} & \delta_{yz}^2 & \delta_{zz}\delta_{yz} \\
 \delta_{xx}\delta_{zz} & \delta_{yx}\delta_{zz} & \delta_{zx}\delta_{zz} & \delta_{xy}\delta_{zz} & \delta_{yy}\delta_{zz} & \delta_{zy}\delta_{zz} & \delta_{xz}\delta_{zz} & \delta_{yz}\delta_{zz} & \delta_{zz}^2
 \end{bmatrix}$$

$$\left[\begin{array}{c|c|c} e_x \otimes e_x & e_x \otimes e_y & e_x \otimes e_z \\ \hline e_y \otimes e_x & e_y \otimes e_y & e_y \otimes e_z \\ \hline e_z \otimes e_x & e_z \otimes e_y & e_z \otimes e_z \end{array} \right]$$



$$\begin{bmatrix} S_{xx}(t) & S_{xy}(t) & S_{xz}(t) \\ S_{yx}(t) & S_{yy}(t) & S_{yz}(t) \\ S_{zx}(t) & S_{zy}(t) & S_{zz}(t) \end{bmatrix}$$

$$\text{Daeg}^{(2)}(t) =$$







$\overline{\delta_{xx}^2}$	\cdot	\cdot	\cdot	$\overline{\delta_{xy}^2}$	\cdot	\cdot	\cdot	$\overline{\delta_{xz}^2}$
\cdot	$\overline{\delta_{xx}\delta_{yy}}$	\cdot	$\overline{\delta_{xy}\delta_{yx}}$	\cdot	\cdot	\cdot	\cdot	\cdot
\cdot	\cdot	$\overline{\delta_{xx}\delta_{zz}}$	\cdot	\cdot	\cdot	$\overline{\delta_{xz}\delta_{zx}}$	\cdot	\cdot
\cdot	$\overline{\delta_{yx}\delta_{xy}}$	\cdot	$\overline{\delta_{yy}\delta_{xx}}$	\cdot	\cdot	\cdot	\cdot	\cdot
$\overline{\delta_{yx}^2}$	\cdot	\cdot	\cdot	$\overline{\delta_{yy}^2}$	\cdot	\cdot	\cdot	$\overline{\delta_{yz}^2}$
\cdot	\cdot	\cdot	\cdot	\cdot	$\overline{\delta_{yy}\delta_{zz}}$	\cdot	$\overline{\delta_{yz}\delta_{zy}}$	\cdot
\cdot	\cdot	$\overline{\delta_{zx}\delta_{xz}}$	\cdot	\cdot	\cdot	$\overline{\delta_{zz}\delta_{xx}}$	\cdot	\cdot
\cdot	\cdot	\cdot	\cdot	\cdot	$\overline{\delta_{zy}\delta_{yz}}$	\cdot	$\overline{\delta_{zz}\delta_{yy}}$	\cdot
$\overline{\delta_{zx}^2}$	\cdot	\cdot	\cdot	$\overline{\delta_{zy}^2}$	\cdot	\cdot	\cdot	$\overline{\delta_{zz}^2}$













POOR

REPO REPO









3



24

$\gamma_1 \gamma_2 s \hbar$



$(r)_3$





15kT



B_0^2









$$\int_0^{t_{\max}}$$

































A_{xx} A_{yy} A_{xy} A_{xz} A_{yz}

$$\begin{bmatrix} \text{Daeg}_{xxx} - \text{Daeg}_{zxzx} & \text{Daeg}_{yxyx} - \text{Daeg}_{zxzx} & \text{Daeg}_{xxyx} + \text{Daeg}_{yxxx} & \text{Daeg}_{xxzx} + \text{Daeg}_{zxxx} & \text{Daeg}_{yxxz} + \text{Daeg}_{zxxy} \\ \text{Daeg}_{xyxy} - \text{Daeg}_{zyzy} & \text{Daeg}_{yyyy} - \text{Daeg}_{zyzy} & \text{Daeg}_{xyyy} + \text{Daeg}_{yyxy} & \text{Daeg}_{xyzy} + \text{Daeg}_{zyxy} & \text{Daeg}_{yyzy} + \text{Daeg}_{zyyy} \\ \text{Daeg}_{xxxy} - \text{Daeg}_{zxzy} & \text{Daeg}_{yxyy} - \text{Daeg}_{zxzy} & \text{Daeg}_{xxyy} + \text{Daeg}_{yxxxy} & \text{Daeg}_{xxzy} + \text{Daeg}_{zxxy} & \text{Daeg}_{yxxzy} + \text{Daeg}_{zxxyy} \\ \text{Daeg}_{xxxz} - \text{Daeg}_{zxzz} & \text{Daeg}_{yxyz} - \text{Daeg}_{zxzz} & \text{Daeg}_{xxyz} + \text{Daeg}_{yxxz} & \text{Daeg}_{xxzz} + \text{Daeg}_{zxzx} & \text{Daeg}_{yxxzz} + \text{Daeg}_{zxxyz} \\ \text{Daeg}_{xyxz} - \text{Daeg}_{zyzz} & \text{Daeg}_{yyyz} - \text{Daeg}_{zyzz} & \text{Daeg}_{xyyz} + \text{Daeg}_{yyxz} & \text{Daeg}_{xyzz} + \text{Daeg}_{zyxz} & \text{Daeg}_{yyzz} + \text{Daeg}_{zyyz} \end{bmatrix}$$









A_0

A_1

A_2

A_3

A_4

$$\begin{bmatrix} \text{Daeg}_{00} - \text{Daeg}_{80} & \text{Daeg}_{40} - \text{Daeg}_{80} & \text{Daeg}_{10} + \text{Daeg}_{30} & \text{Daeg}_{20} + \text{Daeg}_{60} & \text{Daeg}_{50} + \text{Daeg}_{70} \\ \text{Daeg}_{04} - \text{Daeg}_{84} & \text{Daeg}_{44} - \text{Daeg}_{84} & \text{Daeg}_{14} + \text{Daeg}_{34} & \text{Daeg}_{24} + \text{Daeg}_{64} & \text{Daeg}_{54} + \text{Daeg}_{74} \\ \text{Daeg}_{01} - \text{Daeg}_{81} & \text{Daeg}_{41} - \text{Daeg}_{81} & \text{Daeg}_{11} + \text{Daeg}_{31} & \text{Daeg}_{21} + \text{Daeg}_{61} & \text{Daeg}_{51} + \text{Daeg}_{71} \\ \text{Daeg}_{02} - \text{Daeg}_{82} & \text{Daeg}_{42} - \text{Daeg}_{82} & \text{Daeg}_{12} + \text{Daeg}_{32} & \text{Daeg}_{22} + \text{Daeg}_{62} & \text{Daeg}_{52} + \text{Daeg}_{72} \\ \text{Daeg}_{05} - \text{Daeg}_{85} & \text{Daeg}_{45} - \text{Daeg}_{85} & \text{Daeg}_{15} + \text{Daeg}_{35} & \text{Daeg}_{25} + \text{Daeg}_{65} & \text{Daeg}_{55} + \text{Daeg}_{75} \end{bmatrix}$$

A_0 A_1 A_2 A_3 A_4







C



|

7

2

|

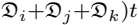
5



Q. 1

Q. 2





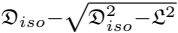




















$$200 + \sqrt{200} = 200$$





2015









$$\mathcal{D}_i - \mathcal{D}_{iso}$$

$$\sqrt{\mathcal{D}_{iso}^2 - \mathcal{L}^2}$$

$$\mathcal{D}_{iso} = \frac{1}{3} \sum_i \mathcal{D}_i,$$

$$a^2 = \frac{1}{3} \sum_{i < j} d_i d_j,$$



$$\frac{\theta'_x + \theta'_y}{2}$$

Condition	Permutation name	Cone half-angles $[\theta'_x, \theta'_y, \sigma'_{\max}]$	Axes $[x', y', z']$
$\theta_x \leq \theta_y \leq \sigma_{\max}$	Self ¹	$[\theta_x, \theta_y, \sigma_{\max}]$	$[x, y, z]$
	A	$[\theta_x, \sigma_{\max}, \theta_y]$	$[-z, y, x]$
	B	$[\theta_y, \sigma_{\max}, \theta_x]$	$[z, x, y]$
$\theta_x \leq \sigma_{\max} \leq \theta_y$	Self ¹	$[\theta_x, \theta_y, \sigma_{\max}]$	$[x, y, z]$
	A	$[\theta_x, \sigma_{\max}, \theta_y]$	$[-z, y, x]$
	B	$[\sigma_{\max}, \theta_y, \theta_x]$	$[x, -z, y]$
$\sigma_{\max} \leq \theta_x \leq \theta_y$	Self ¹	$[\theta_x, \theta_y, \sigma_{\max}]$	$[x, y, z]$
	A	$[\sigma_{\max}, \theta_x, \theta_y]$	$[y, z, x]$
	B	$[\sigma_{\max}, \theta_y, \theta_x]$	$[x, -z, y]$

¹ The first optimised solution.

$$\begin{pmatrix} 1 & 0 & 0 & 0 & 0 & 0 \\ -1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 & 0 \\ 0 & -1 & 0 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & -1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & -1 & 0 & 0 \\ 0 & 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & -1 & 0 \\ 0 & 0 & 0 & 0 & 0 & 1 \\ 0 & 0 & 0 & 0 & 0 & -1 \end{pmatrix}$$

P_x P_y P_z p_x p_y p_z

— 500

— 500

— 500

— 500

— 500

— 500

— 999

— 999

— 999

— 999

— 999

— 999

$$\begin{pmatrix} 1 & 0 & 0 & 0 & 0 \\ -1 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 \\ 0 & -1 & 0 & 0 & 0 \\ 0 & -1 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & -1 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & -1 & 0 \\ 0 & 0 & 0 & 0 & 1 \\ 0 & 0 & 0 & 0 & -1 \end{pmatrix}$$

$$\begin{pmatrix} \theta \\ \theta_x \\ \theta_y \\ \sigma_{\max} \\ \sigma_{\max,2} \end{pmatrix}$$

0

$-\pi$

0

$-\pi$

0

0

$-\pi$

0

$-\pi$

0

$-\pi$



$$\sqrt{\frac{(f^2) - (f)^2}{N}}$$







FOR THE PEOPLE

Exercises 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63, 64, 65, 66, 67, 68, 69, 70, 71, 72, 73, 74, 75, 76, 77, 78, 79, 80, 81, 82, 83, 84, 85, 86, 87, 88, 89, 90, 91, 92, 93, 94, 95, 96, 97, 98, 99, 100.

images/cam_iq_abc_whole_structural_noise-eps-converted-to.pdf





min



$$\frac{(y_i - y_i(\theta))^2}{\sigma_i^2}$$

$$\begin{pmatrix} \frac{\partial}{\partial \theta_1} \\ \frac{\partial}{\partial \theta_2} \\ \vdots \\ \frac{\partial}{\partial \theta_n} \end{pmatrix}$$



$$\begin{pmatrix} \frac{\partial^2}{\partial \theta_1^2} & \frac{\partial^2}{\partial \theta_1 \cdot \partial \theta_2} & \cdots & \frac{\partial^2}{\partial \theta_1 \cdot \partial \theta_n} \\ \frac{\partial^2}{\partial \theta_2 \cdot \partial \theta_1} & \frac{\partial^2}{\partial \theta_2^2} & \cdots & \frac{\partial^2}{\partial \theta_2 \cdot \partial \theta_n} \\ \vdots & \vdots & \ddots & \vdots \\ \frac{\partial^2}{\partial \theta_n \cdot \partial \theta_1} & \frac{\partial^2}{\partial \theta_n \cdot \partial \theta_2} & \cdots & \frac{\partial^2}{\partial \theta_n^2} \end{pmatrix}$$







min

per









$$\mathcal{L}_A(\theta, \lambda^k; \mu_k) \stackrel{\text{def}}{=} f(\theta) + \sum_{i \in \mathcal{I}} \Psi(c_i(\theta), \lambda_i^k; \mu_k),$$

$$\begin{cases} -\lambda^k c_i(\theta) + \frac{1}{2\mu_k} c_i^2(\theta) & \text{if } c_i(\theta) - \mu_k \lambda^k \leq 0, \\ -\frac{\mu_k}{2} (\lambda^k)^2 & \text{otherwise.} \end{cases}$$







$$\mathcal{L}_A(\theta, \lambda^k; \mu_k) = \nabla f(\theta) - \sum_{i \in \mathcal{I} | c_i(\theta) \leq \mu_k \lambda_i^k} \left(\lambda_i^k - \frac{c_i(\theta)}{\mu_k} \right) \nabla c_i(\theta),$$

$$\mathcal{L}_A(\theta, \lambda^k; \mu_k) = \nabla^2 f(\theta) + \sum_{i \in \mathcal{I} | c_i(\theta) \leq \mu_k \lambda_i^k} \left[\frac{1}{\mu_k} \nabla c_i^2(\theta) - \left(\lambda_i^k - \frac{c_i(\theta)}{\mu_k} \right) \nabla^2 c_i(\theta) \right].$$

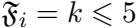
S^2

T_e

$Re x$

$$\left(\begin{array}{c} 1 \\ \infty \\ \infty \end{array} \right)$$

$$\begin{cases} e^{\sum_{i=1}^m -\log(b_i - A_i^T \theta)} & \text{if } A \cdot \theta < b, \\ +\infty & \text{otherwise.} \end{cases}$$







WELCOME TO THE





$\mathcal{D} = 1$, $\mathcal{D} \equiv 4$, $\mathcal{D} \equiv 6$,

$$G = \mathcal{D} \cup \left(\bigcup_{i=1}^l \mathcal{F}_i \right),$$

$$G = \dim \mathcal{D} + \sum_{i=1}^l k_i \leq 6 + 5l,$$













2020

2020











1



2

0

1





$$(\gamma_H \gamma_X h)^2$$

$$< r_6 >$$

od

ov



$$(\gamma_H \gamma_X h)^2$$

$$\langle r^7 \rangle$$

d^2d



d^2



$$(\gamma_H \gamma_X h)^2$$

$$\langle r^8 \rangle$$

$$(\omega_X \cdot \Delta \sigma)^2$$

$$3$$

dc



dΔσ

$$\frac{2w_x^2 \cdot \Delta \sigma}{3}$$

$$d^2c$$

$$d\Delta\sigma^2$$

$$2w^2x$$



$$3$$

dR_{ex}



$d\rho_{ex}$

$$d^2 R_{ex}$$

$$d\rho_{ex}^2$$

$$\frac{\partial J^{R_1}}{\partial d}$$

$$\partial \theta_j$$

$$\frac{\partial J(\omega_H - \omega_X)}{\partial \theta_j}$$

$$\frac{\partial J(w_x)}{\partial \theta_j}$$

$$\partial \theta_j$$

$$\frac{\partial J(\omega_H + \omega_X)}{\partial \theta_j}$$

$$\partial^2 J^{\text{R}_1}_d$$

$$\partial\theta_j \cdot \partial\theta_k$$

$$\frac{\partial^2 J(\omega_H - \omega_X)}{\partial \theta_j \cdot \partial \theta_k}$$

$$\frac{\partial^2 J(\omega_X)}{\partial \theta_j \cdot \partial \theta_k}$$

$$\frac{\partial^2 J(\omega_H + \omega_X)}{\partial \theta_j \cdot \partial \theta_k}$$

$$\frac{\partial J_{R_1}}{\partial c}$$

$$\partial \theta_j$$

$$\partial_c^2 J_{R_1}$$

$$\partial\theta_j.\partial\theta_k$$

$$\frac{\partial J_{R_2}}{\partial d}$$

$$\partial \theta_j$$

$$\frac{\partial J(0)}{\partial \theta_j}$$

$$\partial \theta_j$$

$$\frac{\partial J(\omega_H)}{\partial \theta_j}$$

$$\frac{\partial J_{R_2}}{\partial c}$$

$$\partial \theta_j$$

$$\partial_c^2 J_{R_2}$$

$$\partial\theta_j \cdot \partial\theta_k$$

$$\partial^2 J(0)$$

$$\partial\theta_j \cdot \partial\theta_k$$

$$\frac{\partial J^{\sigma\text{NOE}}}{\partial}$$

$$\partial\theta_j$$

$$\partial^2 J^{\sigma\text{NOE}}_d$$

$$\partial\theta_j \cdot \partial\theta_k$$

$$(1 - S_f^2)(\tau_f + \tau_i)\tau_f$$

$$(\tau_f + \tau_i)^2 + (\omega\tau_f\tau_i)^2$$

$$(S_f^2 - S_i^2)(\tau_s + \tau_i)\tau_s$$

$$(\tau_s + \tau_i)^2 + (\omega\tau_s\tau_i)^2$$



$$\frac{\partial J(\omega)}{\partial \omega_j}$$

$$\frac{\partial J}{\partial \omega_j}$$

dcj



ddj

$$\partial J(\omega)$$

$$\partial S^2$$

1



$$1 + (w\tau_i)^2$$

$$(\tau_e + \tau_i)\tau_e$$

$$(\tau_e + \tau_i)^2 + (\omega\tau_e\tau_i)^2$$

$$\partial J(\omega)$$



$$\partial \tau_e$$

$$(\tau_e + \tau_i)^2 - (\omega \tau_e \tau_i)^2$$

$$(\tau_e + \tau_i)^2 + (\omega \tau_e \tau_i)^2$$

$$\partial^2 J(\omega)$$

$$\partial \mathcal{D}_j \cdot \partial \mathcal{D}_k$$

$$\partial^2 c_j$$



$$\partial \mathcal{D}_j \cdot \partial \mathcal{D}_k$$

$$\partial^2 J(\omega)$$



$$\partial \mathcal{D}_j \cdot \partial S^2$$

$$\partial^2 J(\omega)$$



$$\partial \mathcal{D}_j \cdot \partial \tau_e$$

$$\frac{\partial^2 J(\omega)}{(\partial S^2)^2}$$

$$\partial^2 J(\omega)$$



$$\partial S^2 \cdot \partial \tau_e$$

$$\frac{\partial^2 J(\omega)}{\partial \tau_e^2}$$



$$(\tau_e + \tau_i)^3 + 3\omega^2 \tau_i^3 \tau_e (\tau_e + \tau_i) - (\omega \tau_i)^4 \tau_e^3$$

$$((\tau_e + \tau_i)^2 + (\omega \tau_e \tau_i)^2)^3$$

$$(\tau_s + \tau_i) \tau_s$$

$$(\tau_s + \tau_i)^2 + (\omega \tau_s \tau_i)^2$$

$$\frac{\partial J(\omega)}{\partial s_f^2}$$

$$(\tau_f + \tau_i)\tau_f$$

$$(\tau_f + \tau_i)^2 + (\omega\tau_f\tau_i)^2$$

$$\partial J(\omega)$$

$$\partial \tau_f$$

$$(\tau_f + \tau_i)^2 - (\omega \tau_f \tau_i)^2$$

$$((\tau_f + \tau_i)^2 + (\omega \tau_f \tau_i)^2)^2$$

$$\partial J(\omega)$$

$$\partial \tau_s$$

$$(\tau_s + \tau_i)^2 - (\omega \tau_s \tau_i)^2$$

$$((\tau_s + \tau_i)^2 + (\omega \tau_s \tau_i)^2)^2$$

$$\partial^2 J(\omega)$$

$$\partial \mathcal{D}_j \cdot \partial S_j^2$$

$$\partial^2 J(\omega)$$



$$\partial \mathcal{D}_j \cdot \partial \tau_f$$

$$\partial^2 J(\omega)$$



$$\partial \mathcal{D}_j \cdot \partial \tau_8$$

$$\partial^2 J(\omega)$$

$$\partial S^2 \cdot \partial S^2_f$$

$$\partial^2 J(\omega)$$

$$\partial S^2 \cdot \partial \tau_f$$

$$\partial^2 J(\omega)$$



$$\partial S^2 \cdot \partial \tau_S$$

$$\frac{\partial^2 J(\omega)}{(\partial s_f^2)^2}$$

$$\partial^2 J(\omega)$$

$$\partial s_f^2 \cdot \partial \tau_f$$

$$\partial^2 J(\omega)$$

$$\partial S_f^2 \cdot \partial \tau_s$$

$$\partial^2 J(\omega)$$

$$\partial \tau_f^2$$

$$(\tau_f + \tau_i)^3 + 3\omega^2 \tau_i^3 \tau_f (\tau_f + \tau_i) - (\omega \tau_i)^4 \tau_f^3$$

$$((\tau_f + \tau_i)^2 + (\omega \tau_f \tau_i)^2)^3$$

$$\partial^2 J(\omega)$$

$$\partial \tau_f \cdot \partial \tau_g$$

$$\frac{\partial^2 J(\omega)}{\partial \tau_s^2}$$

$$\frac{(\tau_s + \tau_i)^3 + 3\omega^2 \tau_i^3 \tau_s (\tau_s + \tau_i) - (\omega \tau_i)^4 \tau_s^3}{(\tau_s + \tau_i)^2 + (\omega \tau_s \tau_i)^2}^3$$

$$(\tau_s + \tau_i)^2 + (\omega \tau_s \tau_i)^2$$

$$S_f^2 \cdot S_s^2$$

$$1 + (w_{Ti})^2$$

$$S_f^2(1-S_g^2)(\tau_g+\tau_i)\tau_g$$

$$(\tau_g+\tau_i)^2+(\omega\tau_g\tau_i)^2$$

$$s_g^2$$



$$1 + (\omega \tau_i)^2$$

$$(1 - S_g^2)(\tau_g + \tau_i)\tau_g$$

$$(\tau_g + \tau_i)^2 + (\omega\tau_g\tau_i)^2$$

$$\frac{\partial J(\omega)}{\partial \omega}$$

$$\frac{\partial S^2}{\partial g}$$

$$\partial^2 J(\omega)$$

$$\partial \mathcal{D}_j \cdot \partial S_g^2$$

$$\partial^2 J(\omega)$$

$$\partial S_f^2 \cdot \partial S_g^2$$

$$\frac{\partial^2 J(\omega)}{(\partial s^2)^2}$$

$$\partial^2 J(\omega)$$

$$\partial S_g^2 \cdot \partial \tau_f$$

$$\partial^2 J(\omega)$$

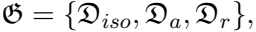
$$\partial S^2_s \cdot \partial \tau_s$$

2



$$i = 2$$







$$2Q_r)(\delta_x^4 + 2\delta_y^2\delta_z^2) + (1 - 3Q_r)(\delta_y^4 + 2\delta_x^2\delta_z^2) - 2(\delta_z^4 + 2\delta_x^2\delta_y^2) \Big].$$



de



adi



$$\partial_r) \left(\delta_x^3 \frac{\partial \delta_x}{\partial \partial_i} + \delta_y \delta_z \left(\delta_y \frac{\partial \delta_z}{\partial \partial_i} + \delta_z \frac{\partial \delta_y}{\partial \partial_i} \right) \right)$$

$$\partial_r) \left(\delta_y^3 \frac{\partial \delta_y}{\partial \partial_i} + \delta_x \delta_z \left(\delta_x \frac{\partial \delta_z}{\partial \partial_i} + \delta_z \frac{\partial \delta_x}{\partial \partial_i} \right) \right)$$



002



003



ad y



ad i

$\partial\delta x$



$\partial\partial i$







de



ds_r

1



P3

$$\mathcal{D}_r)(\delta_x^4 + 2\delta_y^2\delta_z^2) - (1 + \mathcal{D}_r)(\delta_y^4 + 2\delta_x^2\delta_z^2) + 2\mathcal{D}_r(\delta_z^4 + 2\delta_x^2\delta_y^2) \Big].$$

$$\partial^2 e$$

$$\partial \partial_i \cdot \partial \partial_j$$

$$\mathcal{D}_r) \left(\delta_x^2 \left(\delta_x \frac{\partial^2 \delta_x}{\partial \mathcal{D}_i \cdot \partial \mathcal{D}_j} + 3 \frac{\partial \delta_x}{\partial \mathcal{D}_i} \cdot \frac{\partial \delta_x}{\partial \mathcal{D}_j} \right) \right)$$



$$\partial^2 \delta_z$$

$$\partial \partial_i \cdot \partial \partial_j$$

$\partial\delta_z$



$\partial\partial_j$





$$\partial^2 \delta_y$$



$$\partial \partial_i \cdot \partial \partial_j$$

$\partial \delta_y$  $\partial \partial_j$







$$\mathcal{D}_r) \left(\delta_y^2 \left(\delta_y \frac{\partial^2 \delta_y}{\partial \mathcal{D}_i \cdot \partial \mathcal{D}_j} + 3 \frac{\partial \delta_y}{\partial \mathcal{D}_i} \cdot \frac{\partial \delta_y}{\partial \mathcal{D}_j} \right) \right)$$



$$\partial^2 \delta x$$

$$\partial \partial_i \cdot \partial \partial_j$$

$\partial\delta_x$



$\partial\partial_j$







$$\partial^2 e$$



$$\partial \partial_i \cdot \partial \partial_r$$

$$2r \left(\delta_z^3 \frac{\partial \delta_z}{\partial \mathcal{D}_i} + \delta_x \delta_y \left(\delta_x \frac{\partial \delta_y}{\partial \mathcal{D}_i} + \delta_y \frac{\partial \delta_x}{\partial \mathcal{D}_i} \right) \right)$$

$$\partial^2 e$$



$$\partial \partial^2 \gamma$$

1



95

$$2x^2 - 20x + 1 \div (2x^2 + 20x + 1)$$

$$2x^2 + 20x + 1 \div (2x^2 + 20x + 2)$$

$$2021 + 2022 = 4043$$



1



$$i = 1$$





A pixelated, black and white graphic of the word "DANGER" in a bold, sans-serif font. The letters are composed of a grid of black and white pixels, giving it a retro, digital appearance. The word is centered horizontally and occupies the middle portion of the image.

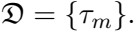




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0=0



deco



σππ

$$\partial^2 c_0$$

$$\partial_{\tau}^2 m$$

$\sigma\pi^0$



$\sigma\pi\pi$

$$\partial^2 \tau_0$$

$$\partial \tau_m^2$$







$\partial\delta_j$



$\partial\partial_j$

2



20j







ad i



ad j

$$\frac{\partial X_H}{\partial \theta_j}$$

$$\frac{\partial \theta_j}{\partial \theta_j}$$







$$\partial^2 \delta_i$$



$$\partial \mathcal{D}_j \cdot \partial \mathcal{D}_k$$

$$\partial^2$$



$$\partial\mathcal{D}_j \cdot \partial\mathcal{D}_k$$

$$\partial^2 \widehat{\mathfrak{D}}_i$$

$$\partial \mathfrak{D}_j \cdot \partial \mathfrak{D}_k$$





$$\begin{pmatrix} \sin \theta \cos \phi \\ \sin \theta \sin \phi \\ \cos \theta \end{pmatrix}$$

2



202







ad



ad

i

$$\partial \overline{X_H}$$

$$\partial \mathcal{D}_i$$

$$\partial^2$$

$$\partial\partial_i \cdot \partial\partial_j$$

$$\partial^2 \widehat{\mathfrak{D}}_{\parallel}$$

$$\partial \mathfrak{D}_i \cdot \partial \mathfrak{D}_j$$

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$$\begin{pmatrix} 1 & \cdot & \cdot \\ \cdot & 1 & \cdot \\ \cdot & \cdot & 1 \end{pmatrix}$$





1234567890









COM-#1







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images/frame_order_matrix/Sijk

$$\begin{pmatrix} \cos \sigma & -\sin \sigma & 0 \\ \sin \sigma & \cos \sigma & 0 \\ 0 & 0 & 1 \end{pmatrix}$$

images/frame_order_matrix/Sij_

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22



22



1



θ_2

max

$$\cos^2 \phi$$

$$\theta_x^2$$

$$\sin^2 \phi$$

$$\theta_y^2$$

images/pseudo_elliptic_cone-eps-converted-

σ_{\max}

$-\sigma_{\max}$







$$\int_{-\sigma_{\max}}^{\sigma_{\max}}$$







$$\frac{1}{\sqrt{\frac{\cos^2 \phi}{\theta_x^2} + \frac{\sin^2 \phi}{\theta_y^2}}}$$





$$\theta_{\max}^2$$



$$2!$$

$$\theta_{\max}^4$$

$$4!$$

$$\theta_{\max}^6$$

$$6!$$

$$\theta_{\max}^8$$

$$8!$$

$$\theta_{\max}^{10}$$

10!



$$(-1)^n$$



$$(2n)!$$

$\pi \theta_x \theta_y$

24





$\pi \theta_x \theta_y$

2880





$\pi \theta_x \theta_y$

322560





$\pi\theta_x\theta_y$

232243200





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$$\begin{pmatrix} \cos^2 \phi \cos \theta + \sin^2 \phi & \cos \phi \sin \phi \cos \theta - \cos \phi \sin \phi & \cos \phi \sin \theta \\ \cos \phi \sin \phi \cos \theta - \cos \phi \sin \phi & \sin^2 \phi \cos \theta + \cos^2 \phi & \sin \phi \sin \theta \\ -\cos \phi \sin \theta & -\sin \phi \sin \theta & \cos \theta \end{pmatrix}$$

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$$\int_{-\sigma_{\max,2}}^{\sigma_{\max,2}}$$

$$\int_{-\sigma_{\max,1}}^{\sigma_{\max,1}}$$



$$\begin{pmatrix} \text{sinc}\sigma_{\text{max},1} & \cdot & \cdot \\ \cdot & \text{sinc}\sigma_{\text{max},2} & \cdot \\ \cdot & \cdot & \text{sinc}\sigma_{\text{max},1}\text{sinc}\sigma_{\text{max},2} \end{pmatrix}$$

Data type	String	Description
S^2 .	's2'	The standard model-free order parameter, equal to S_f^2 . S2s for the two timescale models. The default colour gradient starts at 'yellow' and ends at 'red'.
S_f^2 .	's2f'	The order parameter of the faster of two internal motions. Residues which are described by model-free models m1 to m4, the single timescale models, are illustrated as white neon bonds. The default colour gradient is the same as that for the S^2 data type.
S_s^2 .	's2s'	The order parameter of the slower of two internal motions. This functions exactly as S_f^2 except that S_s^2 is plotted instead.
Amplitude of fast motions.	'amp_fast'	Model independent display of the amplite of fast motions. For residues described by model-free models m5 to m8, the value plotted is that of S_f^2 . However, for residues described by models m1 to m4, what is shown is dependent on the timescale of the motions. This is because these single timescale models can, at times, be perfect approximations to the more complex two timescale models. Hence if τ_e is less than 200 ps, S^2 is plotted. Otherwise the peptide bond is coloured white. The default colour gradient is the same as that for S^2 .
Amplitude of slow motions.	'amp_slow'	Model independent display of the amplite of slow motions, arbitrarily defined as motions slower than 200 ps. For residues described by model-free models m5 to m8, the order parameter S^2 is plotted if $\tau_s > 200$ ps. For models m1 to m4, S^2 is plotted if $\tau_e > 200$ ps. The default colour gradient is the same as that for S^2 .
τ_e .	'te'	The correlation time, τ_e . The default colour gradient starts at 'turquoise' and ends at 'blue'.
τ_f .	'tf'	The correlation time, τ_f . The default colour gradient is the same as that of τ_e .
τ_s .	'ts'	The correlation time, τ_s . The default colour gradient starts at 'blue' and ends at 'black'.
Timescale of fast motions	'time_fast'	Model independent display of the timescale of fast motions. For models m5 to m8, only the parameter τ_f is plotted. For models m2 and m4, the parameter τ_e is plotted only if it is less than 200 ps. All other residues are assumed to have a correlation time of zero. The default colour gradient is the same as that of τ_e .
Timescale of slow motions	'time_slow'	Model independent display of the timescale of slow motions. For models m5 to m8, only the parameter τ_s is plotted. For models m2 and m4, the parameter τ_e is plotted only if it is greater than 200 ps. All other residues are coloured white. The default colour gradient is the same as that of τ_s .
Chemical exchange	'rex'	The chemical exchange, R_{ex} . Residues which experience no chemical exchange are coloured white. The default colour gradient starts at 'yellow' and finishes at 'red'.

Value	Param	Description
None	None	This case is used to set the model parameters prior to minimisation or calculation. The model parameters are set to the default values.
1	None	Invalid combination.
n	None	This case is used to set the model parameters prior to minimisation or calculation. The length of the val array must be equal to the number of model parameters. The parameters will be set to the corresponding number.
None	1	The parameter matching the string will be set to the default value.
1	1	The parameter matching the string will be set to the supplied number.
n	1	Invalid combination.
None	n	Each parameter matching the strings will be set to the default values.
1	n	Each parameter matching the strings will be set to the supplied number.
n	n	Each parameter matching the strings will be set to the corresponding number. Both arrays must be of equal length.