## **Supporting Information**

"Characterizing Anharmonic Vibrational Modes of Quinones with Two-Dimensional Infrared Spectroscopy"

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The remaining slices along  $\omega_{probe}$  are illustrated in Figure S1-3. These slices were used to extract diagonal and off-diagonal anharmonicities. The Figures S1-3 are slices from Figures 2A-C and 3A-C found in the paper. The slices from Figure 2A-C include both ring and carbonyl modes. However, the slices are also taken from Figure 3A-C to only look at the higher frequency modes. The supplemental tables contain the fitting parameters, including peak postion, FWHM and dipole strength, used to fit the slices in the supplemental figures as well as Figure 4A-C. The slices along  $\omega_{probe}$  were fit with Gaussian lineshapes.

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Figure S1. Benzoquinone slice were taken at a) and b)  $\omega_{pump} = 1593 \text{ cm}^{-1}$ , c) and d)  $\omega_{pump} = 1657 \text{ cm}^{-1}$ , e) and f)  $\omega_{pump} = 1671 \text{ cm}^{-1}$ , g)  $\omega_{pump} = 1658 \text{ cm}^{-1}$  and h)  $\omega_{pump} = 1671 \text{ cm}^{-1}$ . Figure 1b, 1d, and 1f) are zoomed in versions of 1a, 1c, and 1e, respectively. Figures S1a-f are slices from Figure 2A in the paper. Figure 1g-h are from Figure 3A in the paper. The slices along  $\omega_{probe}$  were fit with Gaussian lineshapes and the fitting parameters were peak position, FWHM and dipole strength.

Benzoquinone					
	Peak				
	position	FWHM			
$\omega_{\text{pump}} = 1593$	$(cm^{-1})$	$(cm^{-1})$	μ		
(Figure S1a-b)	1595.5	4.00	0.36		
	1590.9	2.27	-0.39		
$\omega_{\text{pump}} = 1657$					
(Figure S1c-d)	1593.4	2.00	0.44		
	1587.7	5.90	-0.34		
$\omega_{\text{pump}} = 1671$					
(Figure S1e-f)	1593.1	3.50	0.36		
	1588.5	5.00	-0.33		
$\omega_{\text{pump}} = 1658$					
(Figure S1g)	1659.6	5.80	0.95		
	1650.6	4.59	-1.00		
$\omega_{\text{pump}} = 1671$					
(Figure S1h)	1671.8	3.90	0.65		
	1664.2	5.15	-0.60		
	1657.2	3.20	0.84		
	1651.0	5.14	-0.74		



Figure S2. Naphthoquinone probe slices were taken at a)  $\omega_{pump} = 1596 \text{ cm}^{-1}$ , b)  $\omega_{pump} = 1662 \text{ cm}^{-1}$  and c)  $\omega_{pump} = 1674 \text{ cm}^{-1}$ . Figure S2a is a slice from Figure 2B in the paper. Figure S2b-c are slices from Figure 3B in the paper. The slices along  $\omega_{pump}$  were fit with Gaussian lineshapes and the fitting parameters were peak position, FWHM and dipole strength.

Naphthoquinone						
$\omega_{\text{pump}} = 1596$	Peak position (cm <sup>-1</sup> )	FWHM (cm <sup>-1</sup> )	μ			
(Figure S2a)	1671.6	1.90	0.50			
	1663.2	3.00	0.38			
	1658.7	4.10	-0.41			
	1655.0	3.00	-0.38			
	1604.6	10.07	0.48			
	1591.7	5.10	-0.57			
$\omega_{\text{pump}} = 1662$						
(Figure S2b)	1673.2	6.00	0.72			
	1664.4	5.15	0.78			
	1656.1	3.90	0.80			
	1650.7	4.40	0.81			
$\omega_{\text{pump}} = 1674$						
(Figure S2c)	1674.0	6.95	0.95			
	1656.6	5.50	-1.00			



Figure S3. Anthraquinone probe slices were taken at  $\omega_{pump} = 1593 \text{ cm}^{-1}$  and  $\omega_{pump} = 1675 \text{ cm}^{-1}$ . Figure S3a is a slice from Figure 2C in the paper. Figure S3b is a slice from Figure 3B in the paper. The slices along  $\omega_{pump}$  were fit with Gaussian lineshapes and the fitting parameters were peak position, FWHM and dipole strength.

Anthraquinone					
	Peak				
1506	position	FWHM			
$\omega_{\text{pump}} = 1596$	$(\mathrm{cm}^{-})$	$(cm^{-1})$	μ		
	1677.2	4.85	0.56		
	1671.2	5.17	-0.56		
	1596.6	5.15	0.64		
	1591.3	4.85	-0.68		
$\omega_{\text{pump}} = 1675$					
	1677.7	6.70	1.00		
	1664.5	14.30	-0.82		