Supporting Information

Temperature-dependent excited-state for detecting reversible phase transitions in 2D lead(II) iodide perovskites

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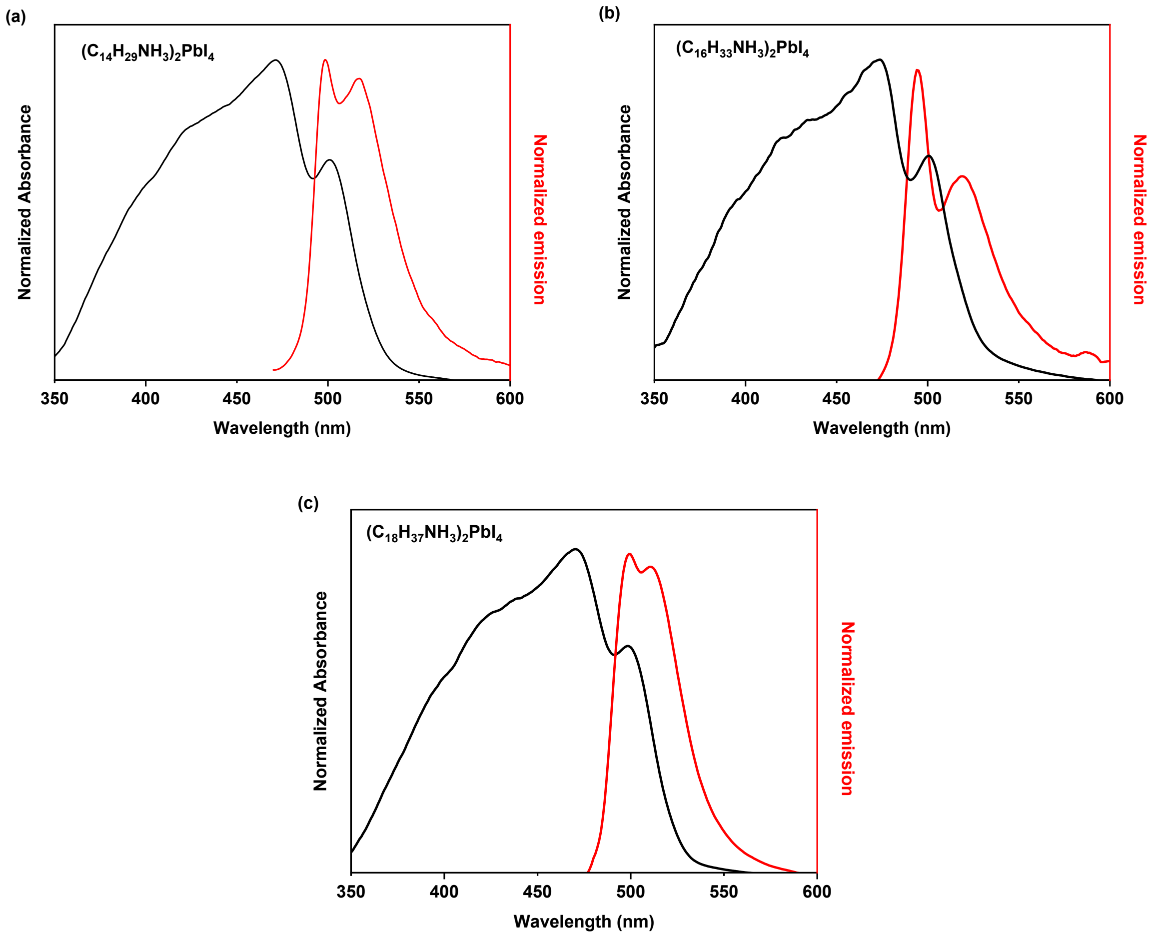
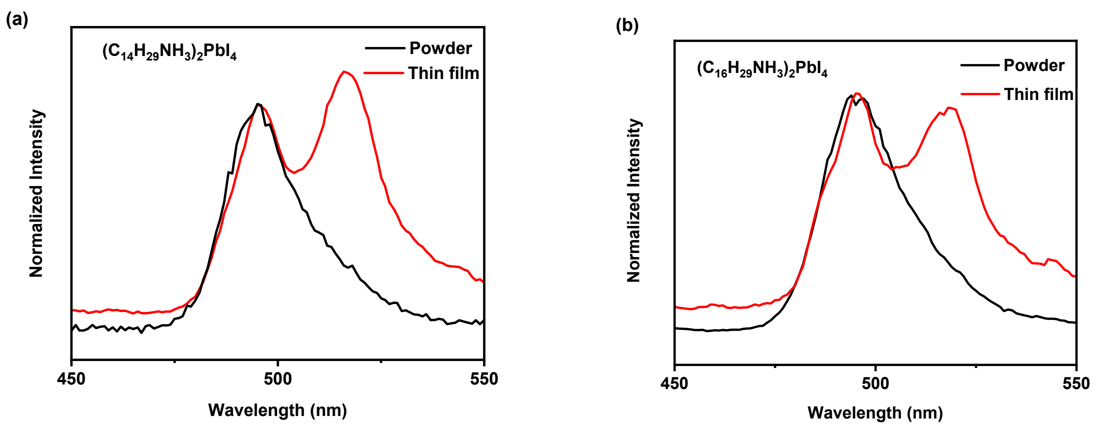


Figure S1. Absorbance and PL emission spectra of powder of (a) $(C_{14}H_{29}NH_3)_2PbI_4$, (b) $(C_{16}H_{33}NH_3)_2PbI_4$, and (c) $(C_{18}H_{37}NH_3)_2PbI_4$ at room temperature.



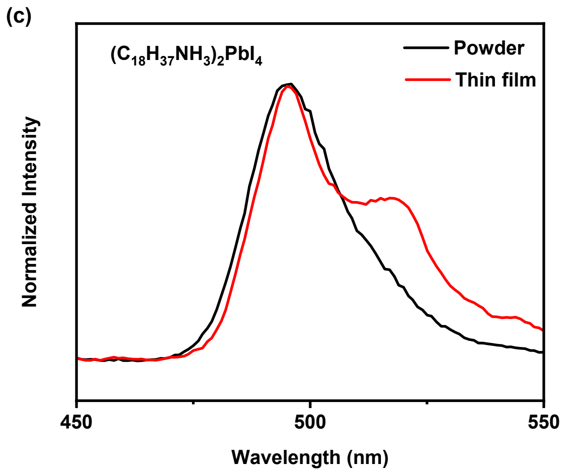


Figure S2. Comparison of PL emission spectra of (a) $(C_{14}H_{29}NH_3)_2PbI_4$, (b) $(C_{16}H_{33}NH_3)_2PbI_4$, and (c) $(C_{18}H_{37}NH_3)_2PbI_4$ thin films and fresh powder samples at room temperature.

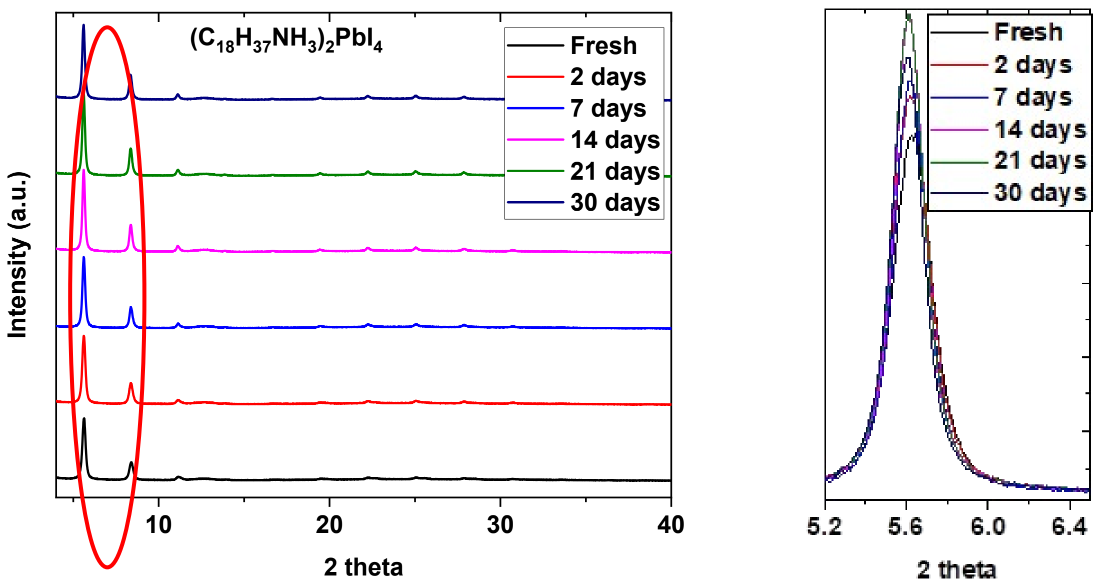


Figure S3. XRD pattern of $(C_{18}H_{37}NH_3)_2PbI_4$ 2D perovskite stored under ambient conditions.

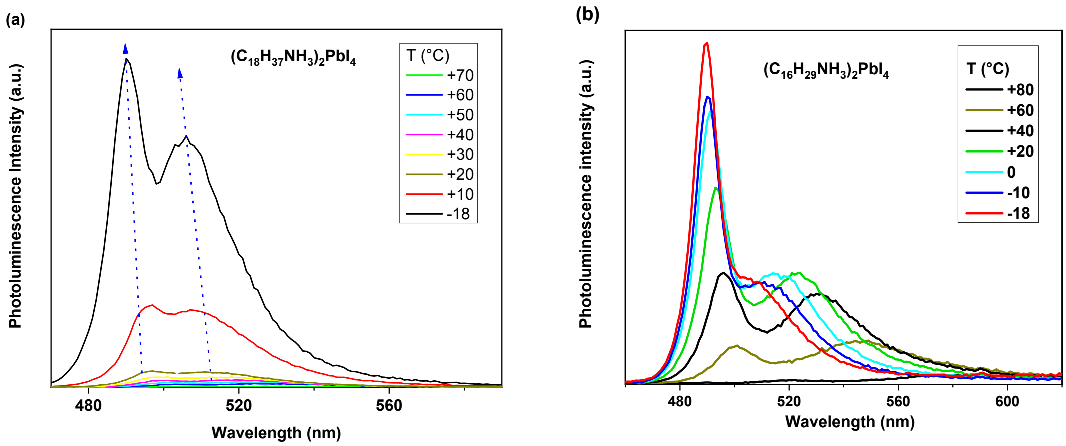


Figure S4. Temperature dependent photoluminescence spectra of (a) $(C_{18}H_{37}NH_3)_2PbI_4$, and (b) $(C_{16}H_{29}NH_3)_2PbI_4$, in the temperature range from 70 to -18 °C (reverse measurement) with λ_{ex} 360 nm.

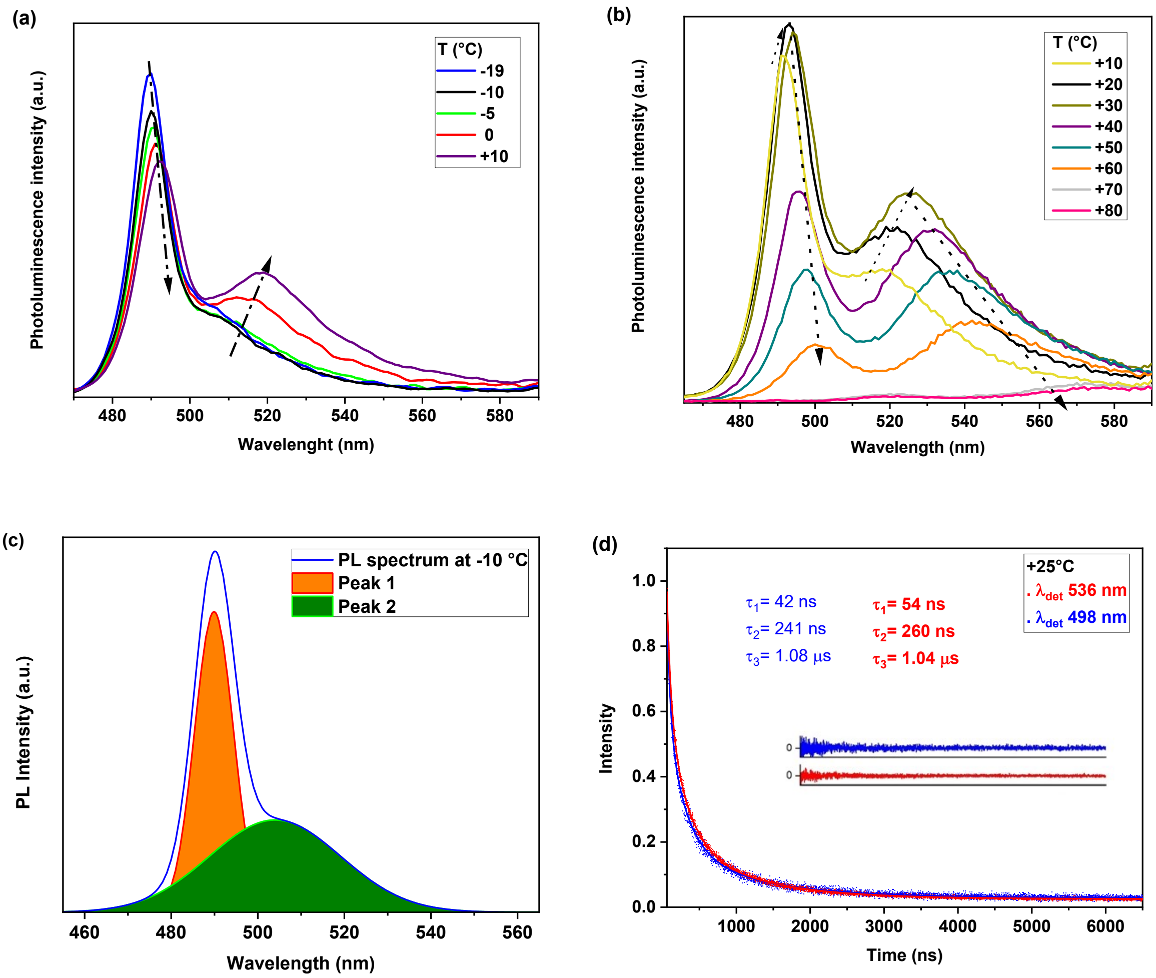


Figure S5. Temperature dependent photoluminescence spectra of $(C_{16}H_{33}NH_3)_2PbI_4$ in the temperature range (a) from -18 to 10 °C, (b) from 10 to 80 °C with λ_{ex} 360 nm. (c) Fitting of PL spectra with Gaussian multi-peak function at -10 °C. (d) Normalized time-resolved photoluminescence decay traces of $(C_{16}H_{33}NH_3)_2PbI_4$ at 25 °C.

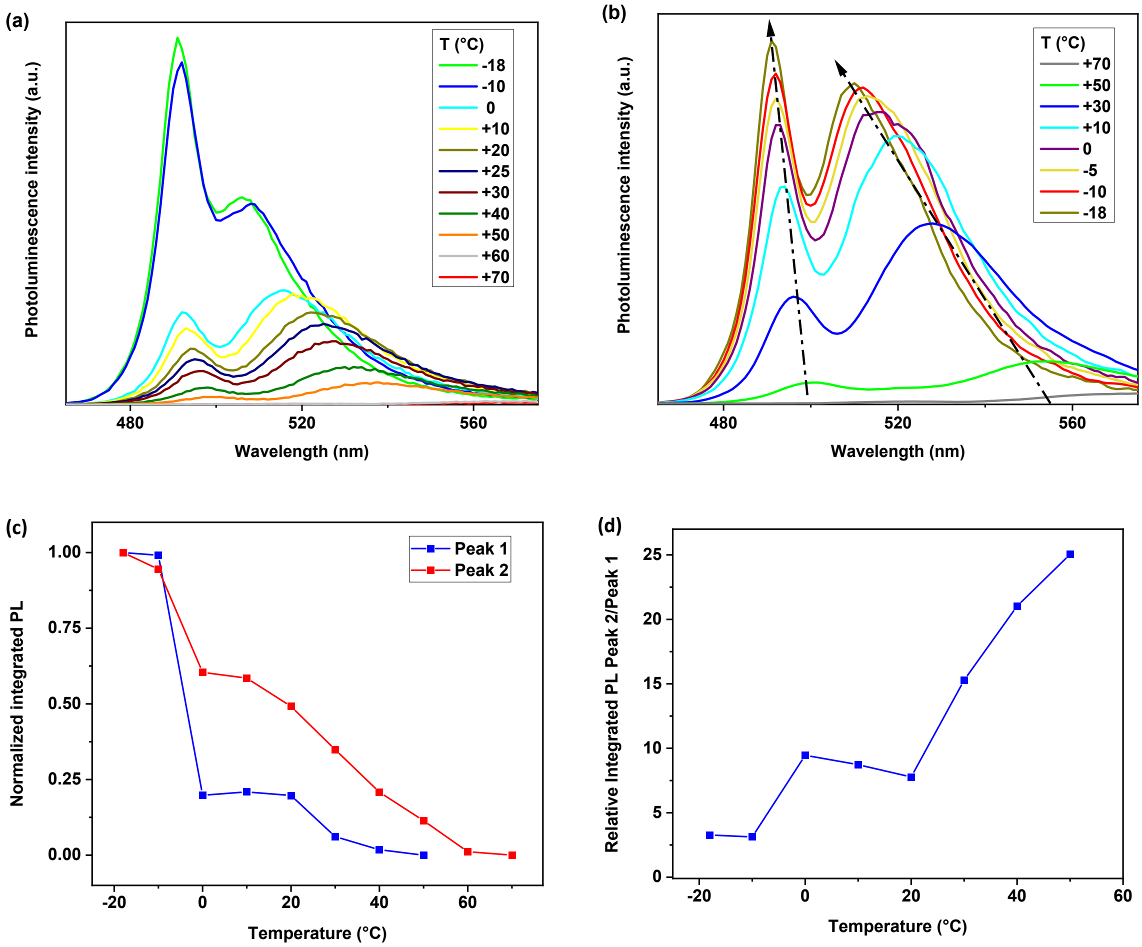


Figure S6. Temperature dependent photoluminescence spectra of $(C_{14}H_{29}NH_3)_2PbI_4$ in the temperature range from (a) -18 to 70 °C, and (b) 70 to -18 °C (reverse). (c) Variation of integrated PL intensity emission peak maxima of $(C_{14}H_{29}NH_3)_2PbI_4$. (d) Relative integrated intensities of comparing the ratio of the low energy (Peak 2) to high energy (Peak 1).

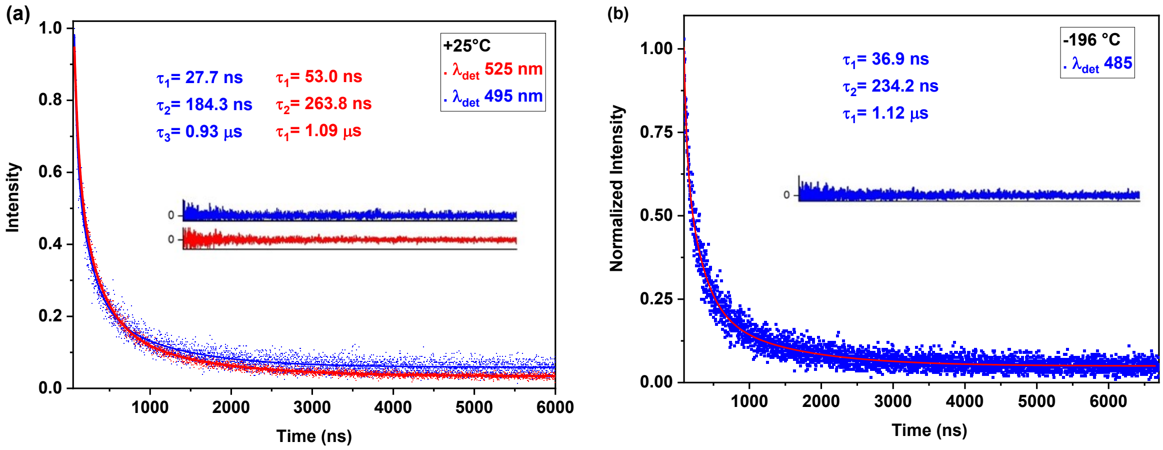


Figure S7. (a) Normalized time-resolved photoluminescence decay traces of $(C_{14}H_{29}NH_3)_2PbI_4$ powders at room temperature with λ_{ex} 360 nm. (b) Normalized time-resolved photoluminescence decay trace of $(C_{14}H_{29}NH_3)_2PbI_4$ powders at -196 °C with λ_{ex} 360 nm.

Table S1. Quantum yield of 2D compounds at different temperatures (°C) with relative method compared to room temperature.

	Temperature (°C)											
Compound	-18	-10	0	10	20	30	40	50	60	70	80	85
$(C_{18}H_{37}NH_3)_2PbI_4$	6.30	3.06	2.83	3.07	2.93	2.57	1.85	1.21	0.74	0.42	0.10	0.06
$(C_{16}H_{33}NH_3)_2PbI_4$	0.14	0.07	0.13	0.18	0.23	0.28	0.21	0.17	0.10	0.023	0.018	
$(C_{14}H_{29}NH_3)_2PbI_4$	3.54	3.52	1.85	1.85	1.61	0.73	0.72	0.44	0.09	0.07		

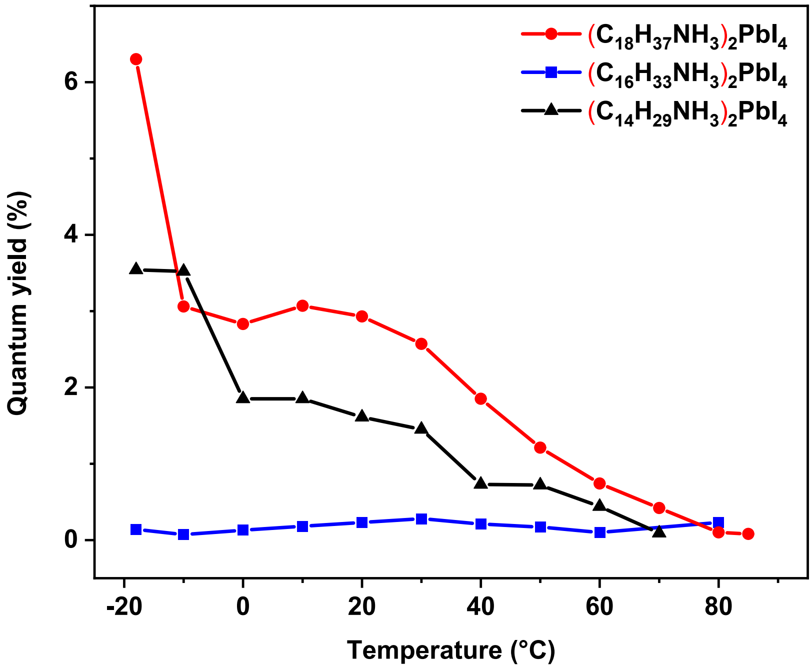


Figure S8. Temperature dependance of photoluminescence quantum yields for 2D perovskite compounds: $(C_{18}H_{37}NH_3)_2PbI_4$, $(C_{16}H_{33}NH_3)_2PbI_4$, and $(C_{14}H_{29}NH_3)_2PbI_4$.