Formation of Mn Doped CH$_3$NH$_3$PbBr$_3$ Perovskite Microrods and Their Collective EMP Lasing

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Figure S1. XRD pattern of the pure and Mn doped CH$_3$NH$_3$PbBr$_3$. According to the XRD patterns, no phase separation of microrods is observed for doped manganese concentration up to 7.35%. Marked peaks (*) is mainly from sample holder. The influence of the substrate has been eliminated.

Figure S2. Optical image of microrod excited by 405nm CW laser.
Figure S3. Optical image of Microrod excited by 400nm femtosecond laser when the power is low.

Figure S4. PL spectra of Mn doped CH$_3$NH$_3$PbBr$_3$ microrod measured in different temperature. Inset is the relationship between PL peak position and experimental temperature.

Figure S5. PL spectra of Mn doped CH$_3$NH$_3$PbBr$_3$ microrods samples (Mn doping
concentration of S2 is higher than S1).

Figure S6. Polarization profile of axis dependent FX emission.

Figure S7. Multi-lasing mode spectra of pure CH$_3$NH$_3$PbBr$_3$ microrod. Combining the multi-mode spectra, we can calculate the length L by the formula $\Delta \lambda = |\lambda_1 - \lambda_2| = \lambda_1 \lambda_2 / 2nL$, where n is the refractive index (n = 2.26 for CH$_3$NH$_3$PbBr$_3$), $\lambda_1$ and $\lambda_2$ are the resonant wavelengths, and $\Delta \lambda$ is the mode spacing. The calculated cavity lengths of adjacent bands are about 45.5 μm, which is closed to the actual length of microrod. Inset is optical image of microrod.