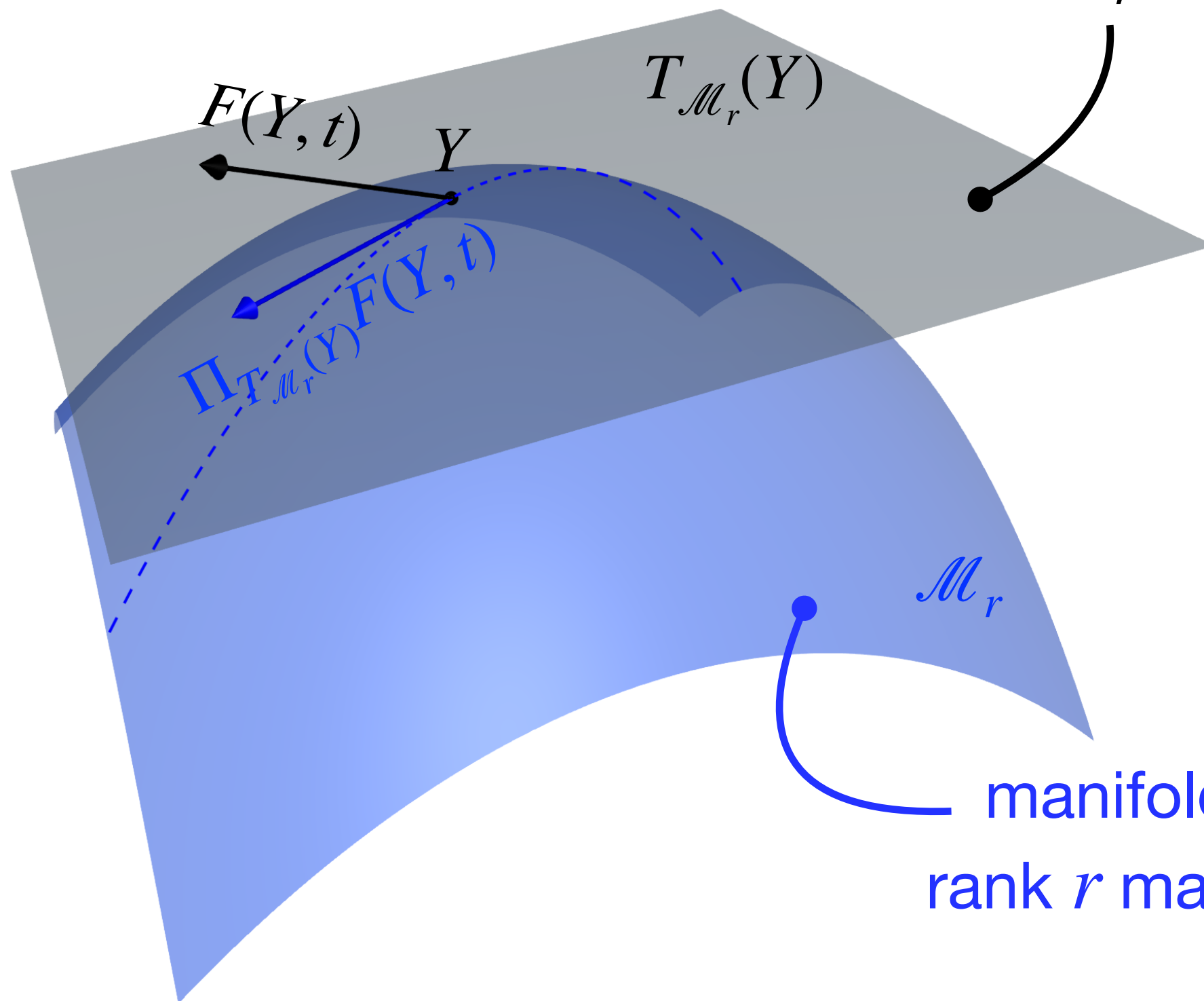


tangent space  
of  $\mathcal{M}_r$  at  $\hat{X}$



manifold of  
rank  $r$  matrices