Linearization Continued

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# Linearization Continued Section 8.4 Follow-Up

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### Review

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The Floer equation is given by

$$\frac{\partial u}{\partial s} + J(u)\frac{\partial u}{\partial t} + \operatorname{grad} H_t(u) = 0.$$

– We fixed a solution and lifted it to a sphere:

$$u \in C^{\infty}(S^1 \times \mathbb{R}; W) \quad \mapsto \quad \tilde{u} \in C^{\infty}(S^2; W)$$

- We use the assumption: For every  $w \in C^{\infty}(S^2, W)$  there exists a symplectic trivialization of the fiber bundle  $w^*TW$ , i.e.  $\langle c_1(TW), \pi_2(W) \rangle =$ 0 where  $c_1$  denotes the first Chern class of the bundle TW.
- We use this trivialize the pullback  $\tilde{u}^*TW$  to obtain an orthonormal unitary frame

$$\{Z_i\}_{i=1}^{2n} \subset T_{u(s,t)}W$$

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– We used the chosen frame  $\{Z_i\}$  to define a chart centered at u of  $\mathcal{P}^{1,p}(x,y)$  given by

$$\iota: W^{1,p}\left(\mathbb{R} \times S^1; \mathbb{R}^{2n}\right) \longrightarrow \mathcal{P}^{1,p}(x,y)$$
$$Y = (y_1, \dots, y_{2n}) \longmapsto \exp_u\left(\sum y_i Z_i\right).$$

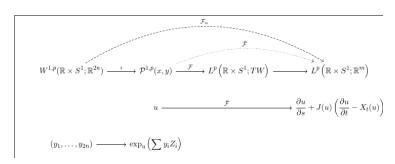
– We regard Y(s,t) as a tangent vector to W in some Euclidean embedding.

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- We seek to compute the composite map in charts:



# Add a Tangent

Linearization Continued

$$\mathcal{F}(u) = \frac{\partial u}{\partial s} + J(u)\frac{\partial u}{\partial t} - J(u)X_t(u)$$

$$\mathcal{F}(u+Y) = \frac{\partial (u+Y)}{\partial s} + J(u+Y)\frac{\partial (u+Y)}{\partial t} - J(u+Y)X_t(u+Y)$$

Extract the part that is linear in *Y* and collect terms:

$$(d\mathcal{F})_{u}(Y)$$

$$= \frac{\partial Y}{\partial s} + (dJ)_{u}(Y)\frac{\partial u}{\partial t} + J(u)\frac{\partial Y}{\partial t} - (dJ)_{u}(Y)X_{t} - J(u)(dX_{t})_{u}(Y)$$

$$= \left(\frac{\partial Y}{\partial s} + J(u)\frac{\partial Y}{\partial t}\right)$$

$$+ \left((dJ)_{u}(Y)\frac{\partial u}{\partial t} - (dJ)_{u}(Y)X_{t} - J(u)(dX_{t})_{u}(Y)\right)$$

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Recall the Leibniz rule

$$(d\mathcal{F})_{u}(Y) = \left(\frac{\partial Y}{\partial s} + J(u)\frac{\partial Y}{\partial t}\right)$$

$$+ \left((dJ)_{u}(Y)\frac{\partial u}{\partial t} - (dJ)_{u}(Y)X_{t} - J(u)(dX_{t})_{u}(Y)\right)$$

$$= \sum_{i=1}^{2n} \left(\frac{\partial y_{i}}{\partial s}Z_{i} + \frac{\partial y_{i}}{\partial t}J(u)Z_{i}\right)$$

$$+ \sum_{i=1}^{2n} y_{i} \left(\frac{\partial Z_{i}}{\partial s} + J(u)\frac{\partial Z_{i}}{\partial t} + (dJ)_{u}(Z_{i})\frac{\partial u}{\partial t} - J(u)(dX_{t})_{u}Z_{i} - (dJ)_{u}(Z_{i})X_{t}\right).$$

 $(dJ)(Y) \cdot v = d(Jv)(Y) - Jdv(Y)$