

4. Hoft string exercise 2.1 pg 9.

Substitute in  $X^m = a^m(\sigma^+) + b^m(\sigma^-)$

$$\Rightarrow (\partial_+ X^m)(\partial_- X^m) = (\partial_+ a^m)(\partial_- b^m)$$

$$\text{Suppose } (\partial_+ X^m)(\partial_- X^m) \Big|_{(\sigma_0^+, \sigma_0^-)} = 0$$

$$\text{Then } (\partial_+ a^m)(\partial_- b^m) \Big|_{(\sigma_0^+, \sigma_0^-)} = 0$$

The constraints demand  $(\partial_- b^m)^2 = 0$

$$\Rightarrow (\partial_+ a^m)(\partial_- b^m) \Big|_{(\sigma_0^+, \sigma_0^-)} = (\partial_- b^m)(\partial_- b^m) \Big|_{(\sigma_0^+, \sigma_0^-)} = 0$$

$$\Rightarrow \partial_+ a^m(\sigma_0^+) = c \cdot \partial_- b^m(\sigma_0^-)$$

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