

# The Set-down and Set-up of Directionally Spread and Crossing Surface Gravity Wave Groups

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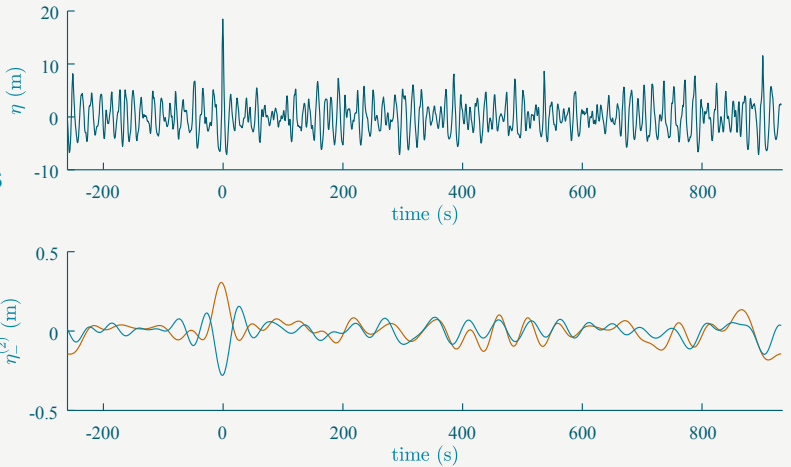
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## Contribution to rogue waves

- A large set-up in second-order difference waves  $\eta_{-}^{(2)}$  was observed under the Draupner rogue wave
- A set-down is typically expected for large waves
- It is thought that this set-up was produced by crossing wave groups

## Experiments

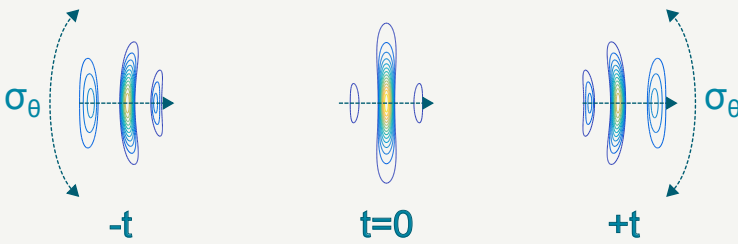
- Experiments were carried out in the FloWave circular wave basin in Edinburgh
- Directionally spread and crossing focused wave groups were created
- The formation of this set-up was examined



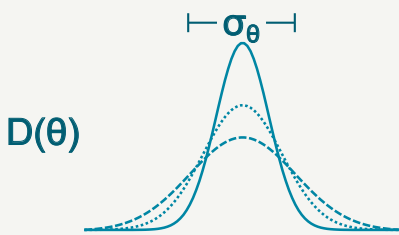
**Fig 1.** Draupner time series recorded at 15:20 on the 1st of January 1995 (top); corresponding second-order difference waves (bottom), observed (orange) and second-order theory predictions for  $\sigma_\theta=20^\circ$  (blue), showing large set-up where set-down is expected.

## Experiments

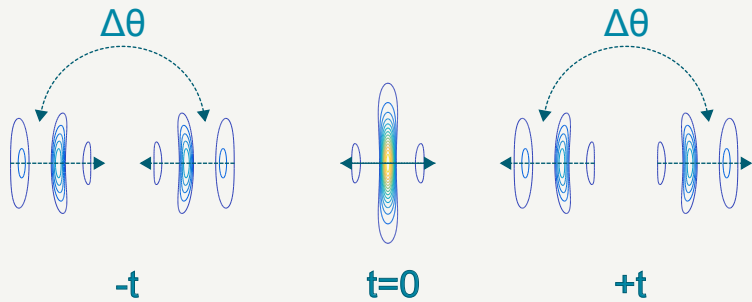
### Directionally Spread Wave Groups: $\sigma_\theta$



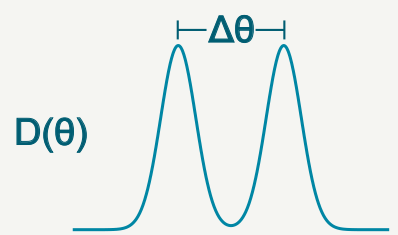
- Single focused Gaussian wave groups
- Degree of directional spreading  $\sigma_\theta$  varied from 0 to  $360^\circ$



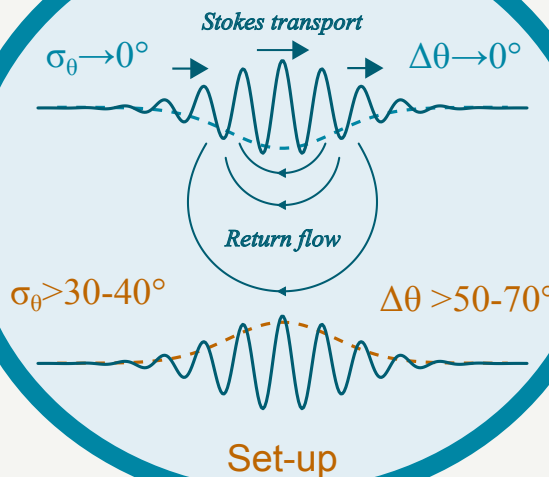
### Crossing Wave Groups: $\Delta\theta$



- Two crossing focused Gaussian wave groups
- Crossing angle between wave groups  $\Delta\theta$  varied between 0 to  $180^\circ$

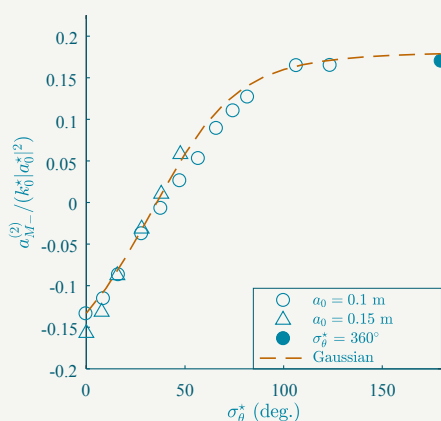


## Results

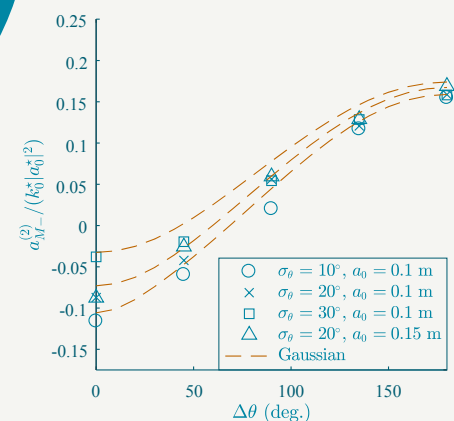


- Experiments match predictions made using second-order theory
- A set-up can occur at  $\sigma_\theta > 50-70^\circ$  or  $\Delta\theta > 50-70^\circ$

- Crossing waves provide a more realistic scenario for a set-up under freak waves in extra-tropical storms
- At full scale this set-up is of order 1m



**Fig 2.** Amplitude of second-order difference waves at the point of linear focus as a function of the estimated degree of directional spreading  $\sigma_\theta^*$ ; the orange dashed line corresponds to a perfectly focused gaussian wave group



**Fig 3.** Amplitude of second-order difference waves at the point of linear focus as a function of crossing angle  $\Delta\theta$ ; the orange dashed lines correspond to two perfectly focused gaussian wave groups with  $\sigma_\theta=10,20,30^\circ$