

Extreme Conditions for Wave Detection with Sensor Arrays

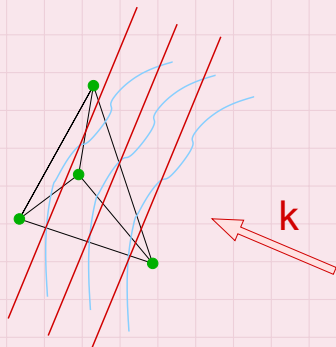
D. Constantinescu^{1,2}

¹Institute for Geophysics and Extraterrestrial Physics, Braunschweig

²Institute for Space Sciences, Bucharest

STIMM-2 Sinaia, June 2007

Wave telescope



- wave field decomposition:

- $B = \sum_{n \text{ (waves)}} C_n \mathbf{w}(\mathbf{k}_n)$

- elementary wave vector: $\mathbf{w}(\mathbf{k}')$

- $w_s \text{ (sensor)} \propto \exp\{i\mathbf{k}' \cdot \mathbf{r}_s\}$

- measurements matrix: B

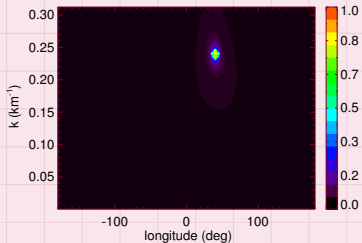
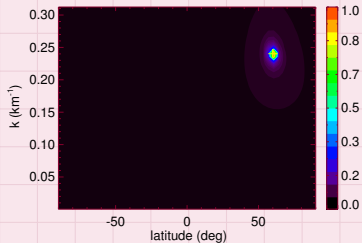
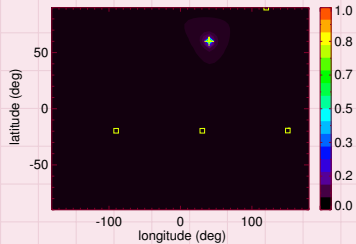
- $B_{ij} = B_i B_j$

Array power = contribution of the wave corresponding to \mathbf{k}'

$$P(\mathbf{k}') = [\mathbf{w}^\dagger(\mathbf{k}') B^{-1}(\omega) \mathbf{w}(\mathbf{k}')]^{-1}$$

Wave telescope example

- one plane wave
($\lambda = 26$ km)
- regular tetrahedron
($d=10$ km)



Geometrical configuration

- three dimensional configuration (minimum = 4)
- planar configuration (minimum = 3)
- string of pearls (minimum = 2)
- single spacecraft (1)

Wave length domain

- top right:

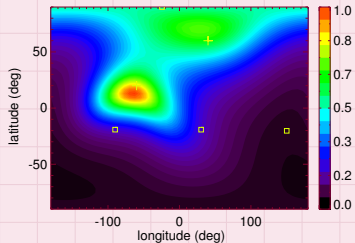
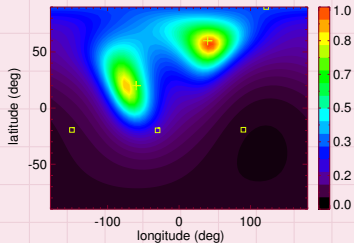
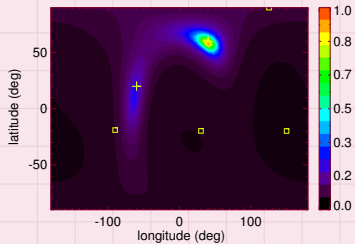
$$\lambda_1 = 10d \quad \lambda_2 = 15d$$

- bottom left:

$$\lambda_1 = 40d \quad \lambda_2 = 60d$$

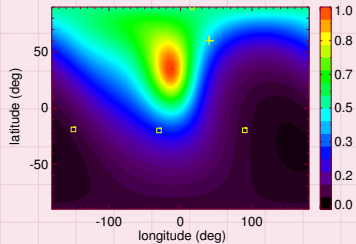
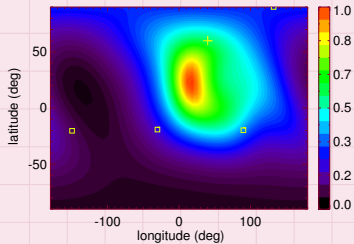
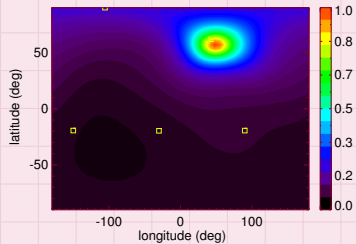
- bottom right:

$$\lambda_1 = 80d \quad \lambda_2 = 120d$$



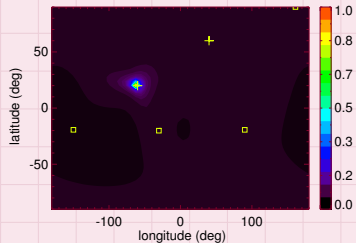
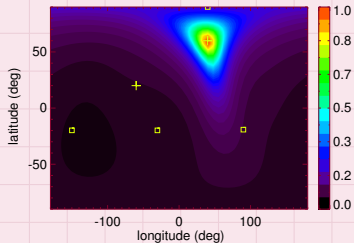
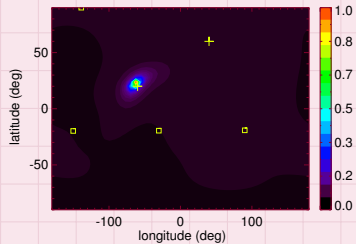
Maximum curvature

- top right: $D=3d$
- bottom left: $D=d$
- bottom right: $D=d/5$



Curvature selection effect

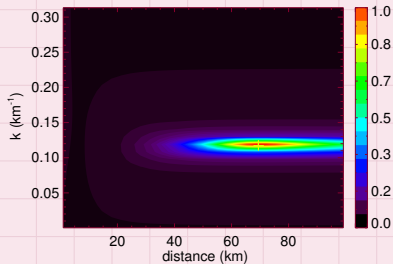
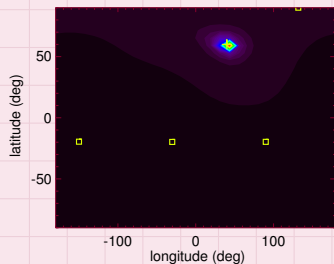
- top right: region 1
($D_1 = 5d$ $D_2 < 4d$)
- bottom left: region 2
($D_1 = 5d$ $6d < D_2 < 70d$)
- bottom right: region 3
($D_1 = 5d$ $D_2 > 70d$)



Source locator

■ new elementary waves: $w_s \propto \rho'_s{}^{-1} \exp\{ik' \rho'_s\}$

■ uses the wave front curvature to determine the source position



Questions

- 1** How important is the number of spacecraft?
- 2** Can the wave telescope provide useful information when applied to 1D or 2D configurations?
- 3** Mixed configurations (Cross Scale): Which is the best approach? ($2d_{\max} < \lambda < 100d_{\min}$)
- 4** How to interpret the wave telescope results in “active” regions?
- 5** Can the curvature provide other information besides the source position?