Synthetic Aperture Radar (Graduate Course) Final Exam

4~6pm, Thursday 16 June 2005 H. Lee

A focused SAR image has the signal $\hat{g} = \exp[-j4\pi R/\lambda]$, where R is the distance between the sensor and the target and λ is the wavelength of the transmitted microwave.

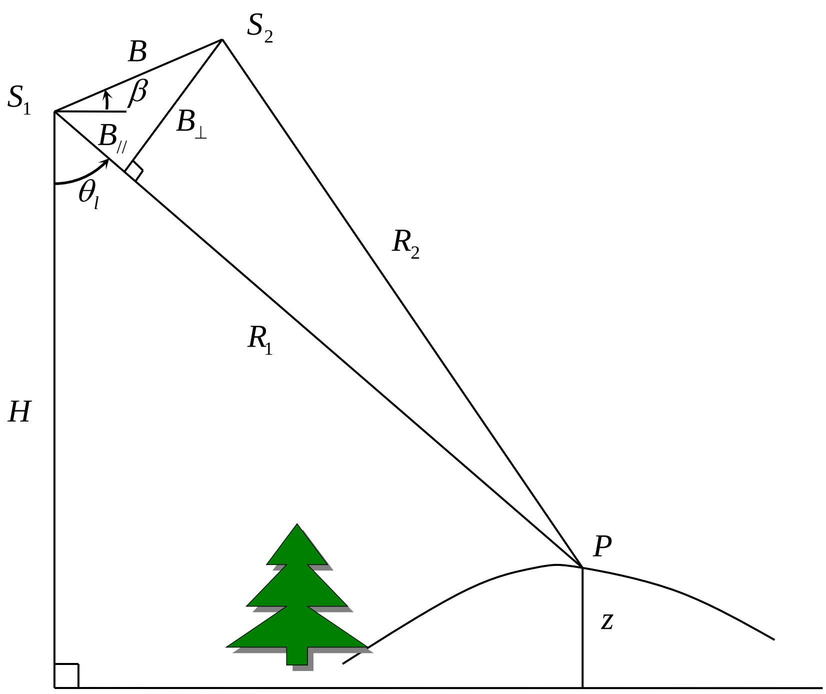
1. What is the phase of the above signal (5P)?
2. What is the physical meaning of the phase, including the minus sign (5P).

Consider an interferometric SAR configuration as shown in the figure far below (next page).

3. Describe the phase difference between two SAR observations (interferometric phase), $\phi = \phi_2 - \phi_1$, in terms of R_1, B, θ_l, and β, from $\Delta S_1 P S_2$. (5P)
4. Show that the interferometric phase can be reduced to $\phi = \frac{4\pi}{\lambda} B\sin(\theta_l - \beta)$. You need to know that R is several hundred kilometers while the baseline B is no more than several hundred meters. As the ratio B/R is very small, you can drop $(B/R)^2$ term during the derivation. Also you need to know that $\sqrt{1 \pm x} \approx 1 \pm \frac{1}{2}x$ when x is very small. (10P)
5. Prove that $\phi = \frac{4\pi}{\lambda} B_{//}$, where $B_{//}$ the component of the baseline parallel to the radar look direction. (5P)
6. Describe the elevation z of the target P, in terms of H, R_1, and θ_l. (5P)
7. Starting from the equations in question 4 and 6, show that the height sensitivity of the interferogram is $\frac{\partial \phi}{\partial z} = \frac{\partial \phi}{\partial \theta}\frac{\partial \theta}{\partial z} = \frac{4\pi B_\perp}{\lambda R_1 \sin\theta_l}$, where $B_\perp$ is the component of the baseline perpendicular to the radar look direction. (5P)
8. Given the phase measurement accuracy of the SAR system is $\delta\phi_{sys}$, find the condition of $B_\perp$ to make the height resolution δz better than the required height resolution δz_{req}, i.e., $\delta z = \frac{\partial z}{\partial \phi}\delta\phi_{sys} < \delta z_{req}$. (5P)
9. Starting from the equations in question 4 and 6, find the interferometric phase fringe number, i.e., the number of 2π phase fringe in slant range is

$$k_\phi = \frac{1}{2\pi}\frac{\partial\phi}{\partial R_1} = \frac{1}{2\pi}\frac{\partial\phi}{\partial\theta}\frac{\partial\theta}{\partial R_1} \approx \frac{2B_\perp}{\lambda R_1 \tan\theta_l} \quad [\mathrm{m}^{-1}] \,. \qquad (5P)$$

10. Given the condition that the interferometric phase fringe number should not exceed one fringe over a slant range resolution δR, i.e., $k_\phi < \frac{1}{\delta R}$, limit the $B_\perp$ to meet this criterion. (5P)
11. Combining the limiting conditions of $B_\perp$ obtained from questions 8 and 10, describe the workable $B_\perp$ of an InSAR system. Note there are more limiting conditions of $B_\perp$ than those shown here. (5P)



Questions about general remote sensing:

12. Describe the four types of resolution concepts used in remote sensing. Explain why it is difficult to make a remote sensor that satisfies the four resolutions simultaneously. (10P)
13. Describe what kind of resolution should be optimized in the study of cartography, geology, meteorology, and oceanography, respectively. (10P)
14. Describe the characteristics of the sun-synchronous orbit. (10P)
15. Describe the conceptual differences of supervised and unsupervised classification. Draw a flow chart of each process if necessary. (10P)

Thanks.