

# Physical Layer Security for mmWave Drone Links with NOMA

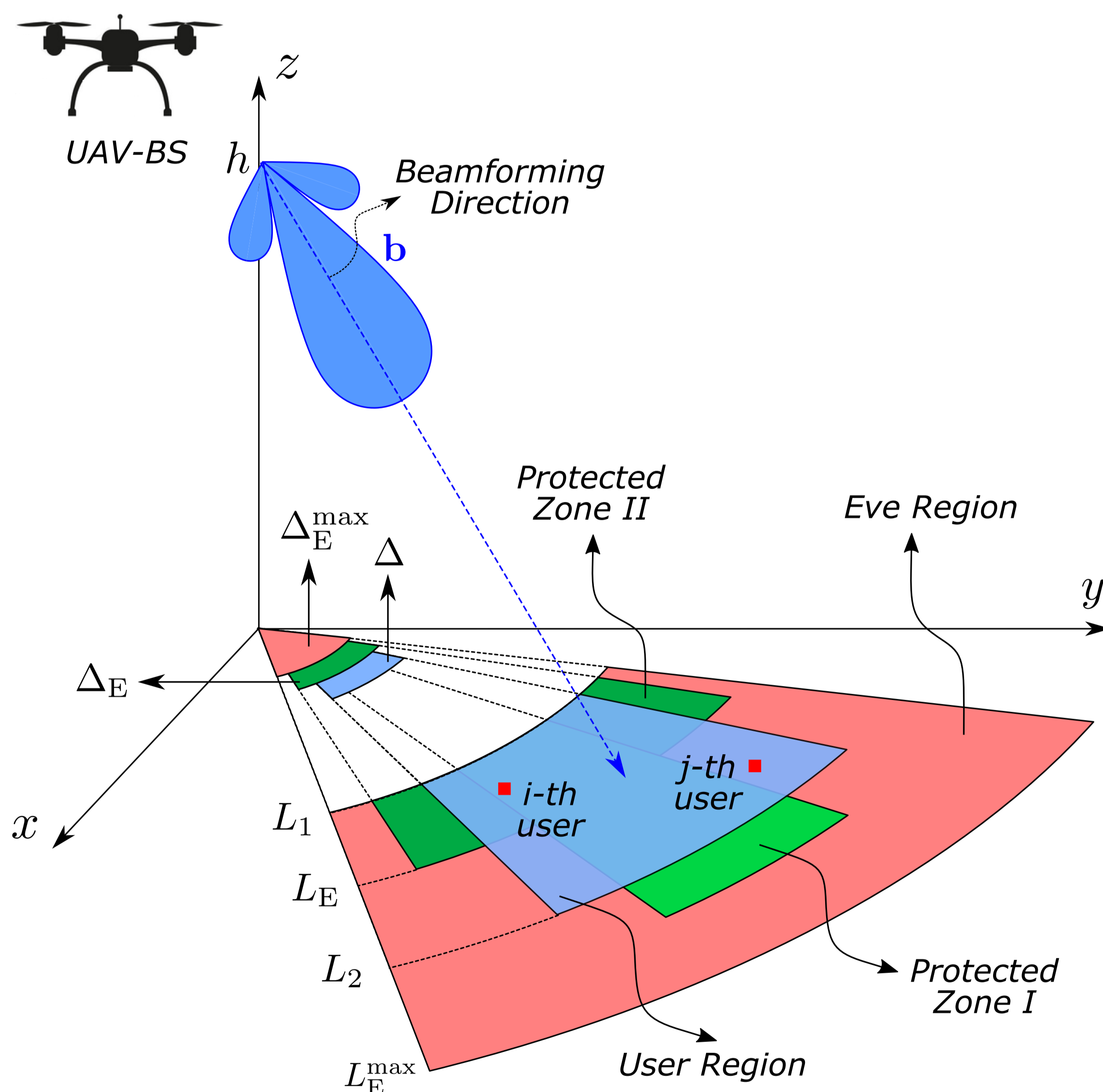
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## Abstract

Non-orthogonal multiple access (NOMA) and millimeter-wave (mmWave) transmission are two prominent technologies for 5G wireless networks where unmanned aerial vehicles (UAVs) act as base stations (e.g., temporary events and disasters).

Physical layer (PHY) security plays a key role in maintaining the confidentiality of the information in 5G networks. In order to improve PHY security, we consider a *protected zone* around the *user region*, which is free from eavesdroppers.



**Figure 1:** System scenario where NOMA transmission serves multiple users simultaneously in a single downlink beam.

## Problem Formulation

Assuming that  $R_k^{\text{NOMA}}$  is rate of the  $k$ th user being served by NOMA, and  $R_{k,E}^{\text{NOMA}}$  is the rate of the respective most detrimental eavesdropper, the secrecy rate is defined as

$$C_k^{\text{NOMA}} = [R_k^{\text{NOMA}} - R_{k,E}^{\text{NOMA}}]^+,$$

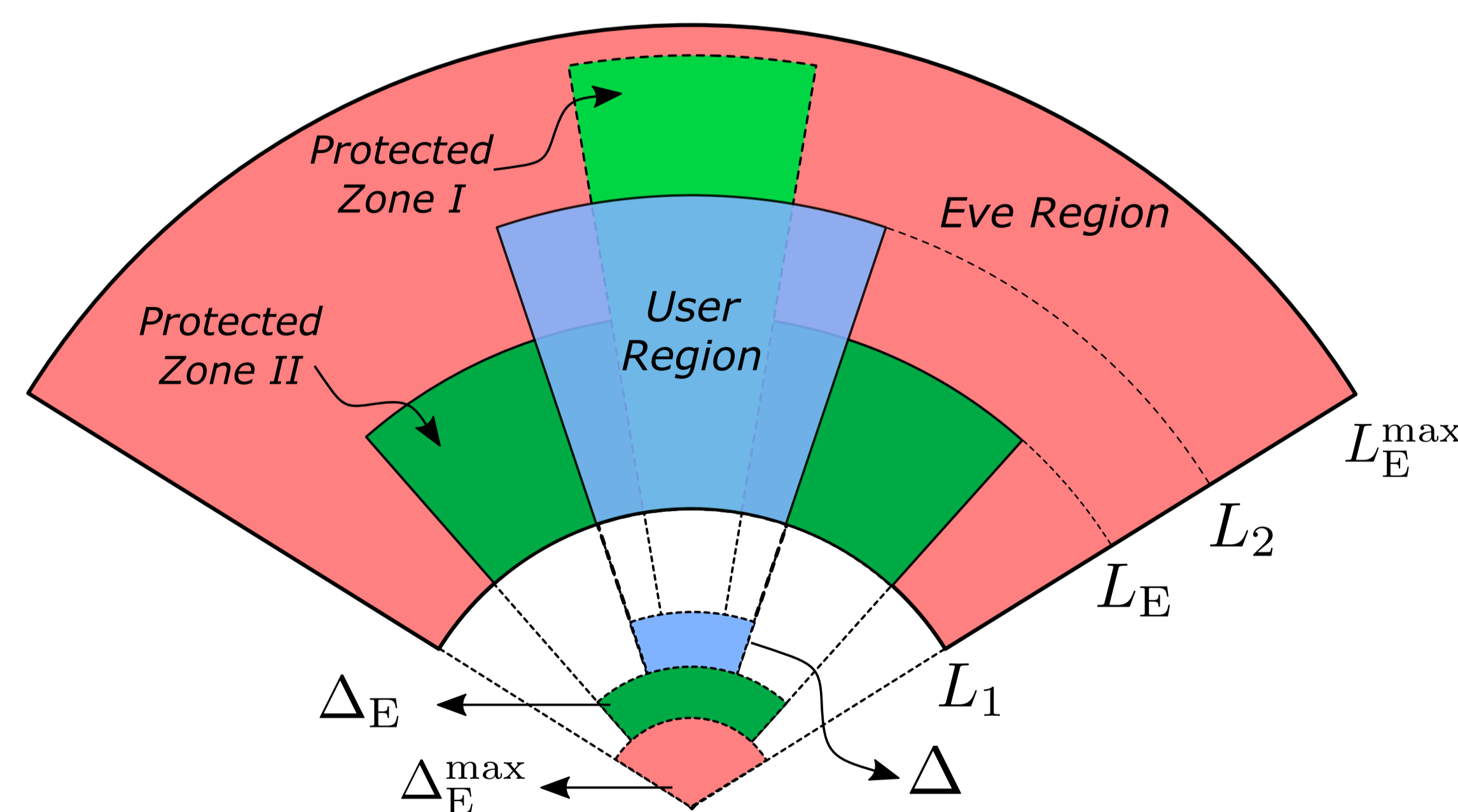
where  $[x]^+ = \max\{x, 0\}$ .

A secrecy outage event occurs with the probability  $P_k^o = P\{C_k^{\text{NOMA}} < \bar{R}_k\}$  with  $\bar{R}_k$  being the respective desired secrecy rate. The outage sum secrecy rate is given as

$$R^{\text{NOMA}} = \sum_{k=1}^K (1 - P_k^o) \bar{R}_k. \quad (1)$$

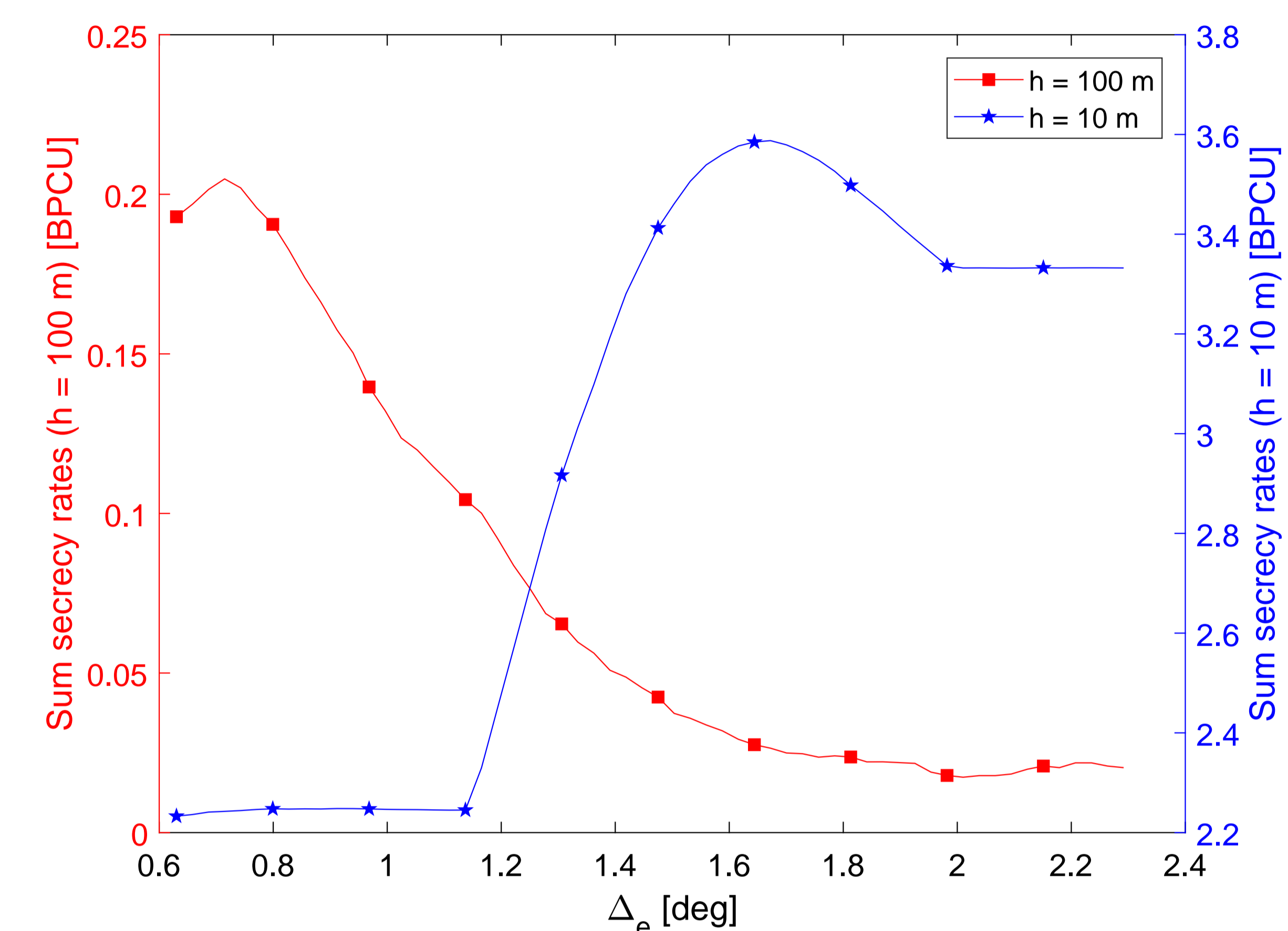
The optimal shape for the protected zone is

$$\Delta_E^*, L_E^* = \operatorname{argmax}_{\Delta_E, L_E} R^{\text{NOMA}} \quad (2)$$

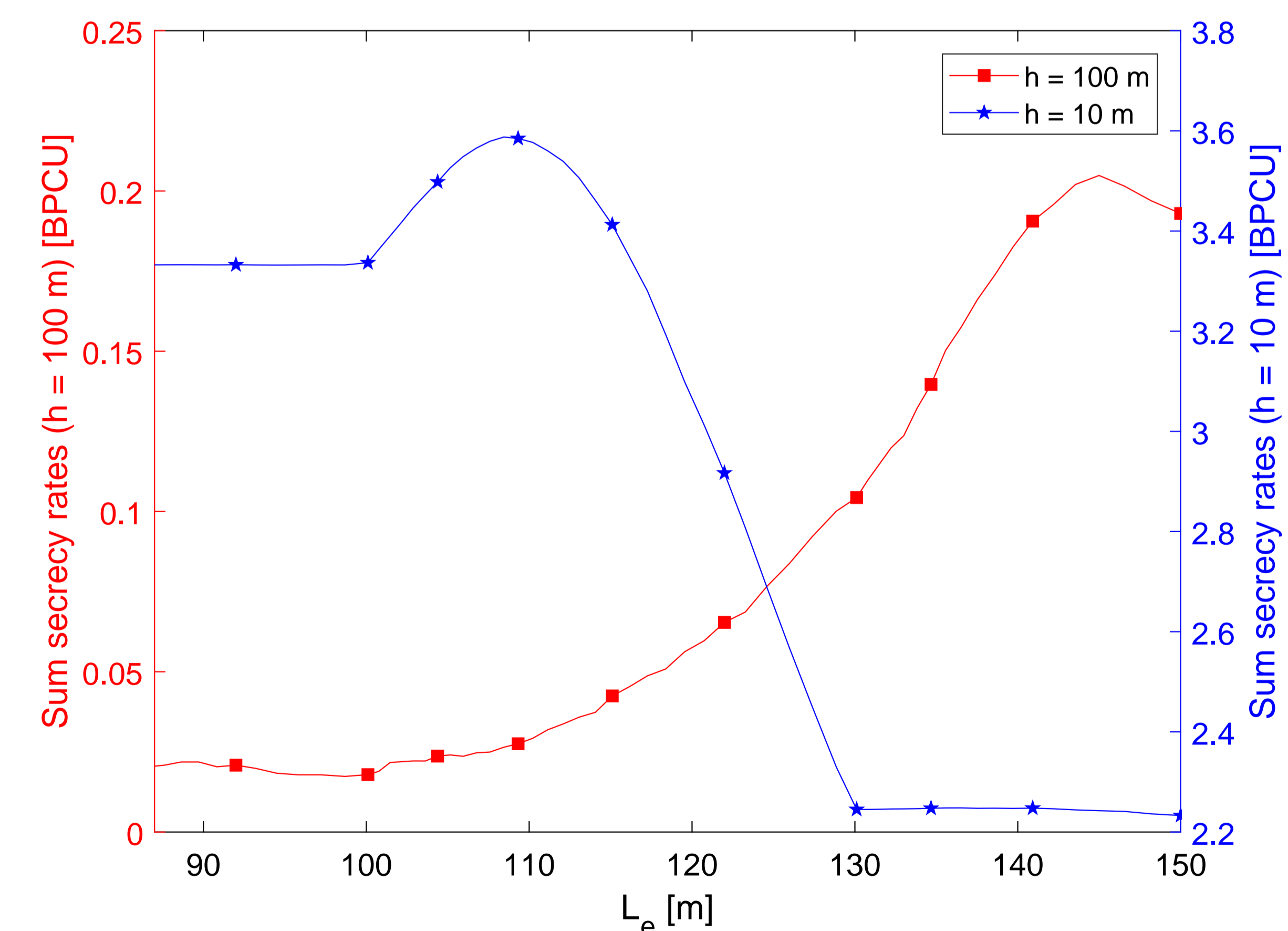


**Figure 2:** Footprint of *protected zone* represented by angle-distance pair  $(\Delta_E, L_E)$ , which is free from any eavesdroppers.

## Numerical Results



**Figure 3:** Sum secrecy rates of NOMA along with the protected zone angle (i.e.,  $\Delta_E$ ) for  $h = \{10, 100\}$  m,  $q = 0.2$ , and  $\lambda_E = 0.1$ .



**Figure 4:** Sum secrecy rates of NOMA along with the protected zone distance (i.e.,  $L_E$ ) for  $h = \{10, 100\}$  m,  $q = 0.2$ , and  $\lambda_E = 0.1$ .