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The Effect of Pressure Anisotropy on Ballooning Modes in Tokamak Plasmas

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Edge Localised Modes (ELMs) are thought to be caused by a spectrum of magnetohydrodynamic instabilities, including the ballooning mode. While ballooning modes have been studied extensively both theoretically and experimentally, the focus of the vast majority of this research has been on isotropic plasmas. The prevalence of pressure anisotropy in modern tokamaks thus motivates further study of these modes. This paper presents a numerical analysis of ballooning modes in anisotropic equilibria. The investigation was conducted using the newly-developed codes HELENA+ATF and MISHKA-A, which adds anisotropic physics to equilibria and stability analysis. We have examined the impact of anisotropy on the stability of an n=30 ballooning mode, confirming results conform to previous calculations in the isotropic limit. Growth rates of ballooning modes in equilibria with different levels of anisotropy were then calculated using the stability code MISHKA-A. The key finding is that the level of anisotropy had a significant impact on ballooning mode growth rates. For $T_\perp > T_{||}$, typical of ICRH heating, the growth rate increases, while for $T_\perp < T_{||}$, typical of neutral beam heating, the growth rate decreases. For levels of anisotropy observed in JET and MAST plasmas, we expect the impact on growth rates for realistic configurations to be significant. An important conclusion is the possibility that higher ELM-free performance might be achieved by increasing $p_{||}/p_\perp$ in the pedestal region.

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