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Investigation of turbulent spherical flames

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The role of turbulence is generally taken to be the main cause for the growth of flame-brush thickness in turbulent spherical flames and Taylor's dispersion theory had been used in past studies to support this. Contrary to this view, this study shows that the differential propagation between the leading and trailing edges of the flame-brush is the predominant cause for the growth of the flame-brush thickness with time in the spherical flames. The leading edge accelerates continuously because of the cumulative effect of flow acceleration resulting from heat release. These insights are derived by analysing URANS computations of 7 spherical and 7 planar flames having combustion conditions in the corrugated flamelets and thin reaction zones regimes. The reaction rate closure is achieved using strained premixed flamelets with scalar dissipation rate as a parameter. Detailed analyses of the results showed that the mean reaction rate does not depend on the flame geometry, planar or spherical. However, the turbulent flame speed which is the leading edge displacement speed showed a flame geometry dependence due to the geometry dependence of turbulent scalar flux. The presentation will highlight these physical insights.

In collaboration with I. Ahmed, Cambridge University Engineering Department.