Spline-based radial property reconstruction for noise and trapping correction for emission, light scattering and extinction measurements in axisymmetric sooting flames

Mijail Littin, Guillaume Lefevre, Marek Mazur, Andrés Fuentes, Jérôme Yon

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M. Littin[1], G. Lefevre[1], M. Mazur[1], A. Fuentes[2], and J. Yon[1]

[1]*INSA Rouen Normandie, Univ Rouen Normandie, CNRS, Normandie Univ, CORIA UMR 6614, F-76000 Rouen, France.*
[2]*Departamento de Industrias, Universidad Técnica Federico Santa María, Av. España 1680, Valparaíso, Chile.*

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Abstract

The experimental characterisation of soot particles, which are generated during incomplete combustion of fossil fuels and contribute siginificantly to global warming and respiratory diseases [1], presents a considerable challenge. Recent advancements have brought the innovative techniques of Multiwavelength Line-of-Sight Attenuation (MW-LOSA), Emission [2], and Horizontal Angular Light Scattering (HPALS) [3] to the forefront of in-situ soot measurement techniques. With the help of the RDG-FA light particle interaction theory, these methods are capable of giving access to spatial profiles of integral soot properties such as volume fraction, maturity, particle size, and optical index. However, the complexities associated in extinction, emission and scattering require robust inversion tools. A common problem is the Abel reconstruction of radial symmetric flames, which experiences high noise due to error multiplication [4]. In this context, a novel approach for the Abel inversion is introduced, based on clamped cubic splines. The effect of self-absorption in emission is taken into account, enabling accurate and representative signal reconstruction from extinction/emission measurements in a canonical laminar flame. Additionally, the impact of signal trapping in light scattering measurements is presented. Reliable and precise inversion solutions facilitate accurate soot temperature measurements, volume fraction determination, and optical index assessment, thereby enhancing our understanding of soot formation.

References

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