# A ONE-SHOT APPROACH FOR THE INTRUSIVE POLYNOMIAL MOMENT METHOD

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Abstract. Uncertainty Quantification for fluid dynamics applications becomes a challenging task, especially when the solution shows shocks in the random space. To enable the use of adaptivity, we use intrusive methods, which provide a set of equations describing the time evolution of the polynomial chaos (PC) coefficients. The Intrusive Polynomial Moment (IPM) method [1] possesses a large number of desirable quantities that are violated by standard intrusive methods such as stochastic-Galerkin. However, the IPM system requires solving a convex optimization problem which computes the entropy variables corresponding to a given set of PC coefficients. This optimization problem needs to be solved in every spatial cell in each time step, yielding high computational costs.

In this talk, we present a method to reduce computational costs for steady state problems. To drive the IPM system to its steady state solution, we use explicit Euler steps, while employing Newton's method to solve the mentioned optimization problems. Since the PC coefficients are not at the physically correct steady state solution for a large number of Euler steps, we propose to not solve the IPM optimization problems exactly. Instead, we perform only one step of Newton's method, i.e. we converge the PC coefficients as well as the corresponding entropy variables simultaneously to their steady state solution. It can be shown that this method converges to the steady state solution locally. Due to its similarities to the one-shot method in shape optimization [2], we call this method one-shot IPM.

We demonstrate the effectiveness of one-shot IPM by investigating an inviscid flow around a NACA0012 profile with an uncertain Mach number and far field pressure. When making use of the one-shot approach as well as adaptivity, we are able to compete with non-intrusive collocation methods.

## References

[1] Poëtte, Després, Lucor. Uncertainty quantification for systems of conservation laws. Elsevier *Journal of Computational Physics*, 228(7):2443–2467, 2009.

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