Gauss-Lucas theorem in polynomial dynamics

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Using versions of the Gauss-Lucas theorem adapted to dynamics, we prove that for every complex polynomial $p$ of degree $d \geq 2$ the convex hull $H_p$ of the Julia set $J_p$ of $p$ satisfies $p^{-1}(H_p) \subset H_p$. This settles positively a conjecture by P. Alexandersson. We also characterize the families of polynomials for which the equality $p^{-1}(H_p) = H_p$ is achieved.