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A Generalized Projected CG Method with Applications to Bubbly FLow Problems.

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For various applications, it is well-known that a two-level preconditi oned CG method is an efficient method for solving large and sparse linear system s whose coefficient matrix is SPD. A combination of traditional and projection-t ype preconditioners is used to get rid of the effect of both small and large eig envalues of the coefficient matrix. The resulting methods are called projection methods. In the literature, various projection methods are known, coming from th e fields of deflation, domain decomposition and multigrid. At first glance, thes e methods seem to be different. However, from an abstract point of view, they ar e closely related to each other theoretically. We show that a generalized projec ted CG method can be formulated based on these methods. The various variants are also compared numerically in order to test their robustness, where our main app lications are bubbly flows. The computational cost for the simulations of bubbly flows is often dominated by the solution of a linear system corresponding to a pressure Poisson equation with discontinuous coefficients. We will explore the e fficient solution of these linear systems using projection methods. Some of thes e methods turn out to be very fast and robust, resulting in efficient calculatio ns for bubbly flows on highly resolved grids. We conclude with a suggestion of a two-level preconditioner for the CG method, that is as robust as the abstract b alancing preconditioner and nearly as cheap and fast as the deflation preconditi oner.