Rate Equations with ALI

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One of the kernels of the widely applied Accelerated Lambda Iteration (ALI) for the construction of non-LTE model atmospheres is the solution of the rate equations, i.e. the calculation of level population numbers from a given radiation field. Due to the so-called "acceleration", which is vital for the overall convergence, this set of equations is usually non-linear. In my talk I will discuss the Newton iteration which is the prototype of all fast and reliable methods for the solution of non-linear equations, and its derivatives, namely the Broyden and the Kantorovich method. I will show that the attributes fast and reliable are aligned, which also means that slow methods are virtually of no use. This is demonstrated by means of the slow Unsöld-Lucy temperature correction scheme. I will also show how the non-linear equations can be transformed into linear equations by two techniques named preconditioning and linearization, respectively. At last I will focus on the construction of the Λ-operator, i.e. the "accelerating" term. In static atmospheres the operator can be easily derived from the solution of the radiation transfer while in moving atmospheres life is much more difficult.