^{39}Ar ATTA @ Heidelberg - the atom optical aspect

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The importance of ^{39}Ar as a dating tracer for the time range between 50 and 1000 years has clearly been identified [1]. The detection technique Atom Trap Trace Analysis (ATTA) has been realized for rare krypton isotopes in the past decade [2,3] and its principle applicability to ^{39}Ar has been demonstrated [4]. ATTA has the potential to measure ^{39}Ar on small samples down to less than 1 ccSTP of Argon, corresponding to about 100 ml of air, 2.5 l of water or 1 kg of ice. This would especially enable the application of ^{39}Ar as a tracer in oceanography or glaciology where samples smaller than 10 l of water or 1 kg of ice respectively are required for practical dating purposes.
We report on the development of an ATTA-setup for ^{39}Ar [5] which gives a ^{39}Ar-count rate of 0.6atoms/h for atmospheric samples. Initially, spectroscopy of the relevant hyperfine transition in ^{39}Ar has been performed [6,7]. Based on these results different atom-optical techniques have been developed to achieve the high ^{39}Ar-count rate. Especially, an additional deceleration stage behind the magneto-optical trap center was found to enhance the counting rate by a factor ~4. The ^{40}Ar-background could successfully be eliminated by selectively removing ^{40}Ar atoms with an additional laser frequency and thus allows the detection of single atoms with high signal to noise ratio without switching the trap parameters. A further increase in ^{39}Ar-count rate is intended by systematic studies on enriched samples including the hyperfine nature of ^{39}Ar, which is not present in the abundant argon isotopes.

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