

**Zeitschrift:** Helvetica Physica Acta  
**Band:** 34 (1961)  
**Heft:** [6]: Supplementum 6. Proceedings of the International Symposium on polarization phenomena of nucleons

**Artikel:** An E-H gradient spectrometer  
**Autor:** Eisinger, J. / Bederson, B. / Rubin, K.  
**DOI:** <https://doi.org/10.5169/seals-513264>

#### **Nutzungsbedingungen**

Die ETH-Bibliothek ist die Anbieterin der digitalisierten Zeitschriften auf E-Periodica. Sie besitzt keine Urheberrechte an den Zeitschriften und ist nicht verantwortlich für deren Inhalte. Die Rechte liegen in der Regel bei den Herausgebern beziehungsweise den externen Rechteinhabern. Das Veröffentlichen von Bildern in Print- und Online-Publikationen sowie auf Social Media-Kanälen oder Webseiten ist nur mit vorheriger Genehmigung der Rechteinhaber erlaubt. [Mehr erfahren](#)

#### **Conditions d'utilisation**

L'ETH Library est le fournisseur des revues numérisées. Elle ne détient aucun droit d'auteur sur les revues et n'est pas responsable de leur contenu. En règle générale, les droits sont détenus par les éditeurs ou les détenteurs de droits externes. La reproduction d'images dans des publications imprimées ou en ligne ainsi que sur des canaux de médias sociaux ou des sites web n'est autorisée qu'avec l'accord préalable des détenteurs des droits. [En savoir plus](#)

#### **Terms of use**

The ETH Library is the provider of the digitised journals. It does not own any copyrights to the journals and is not responsible for their content. The rights usually lie with the publishers or the external rights holders. Publishing images in print and online publications, as well as on social media channels or websites, is only permitted with the prior consent of the rights holders. [Find out more](#)

**Download PDF:** 17.01.2026

**ETH-Bibliothek Zürich, E-Periodica, <https://www.e-periodica.ch>**

## An *E-H* Gradient Spectrometer

By J. EISINGER, Bell Telephone Laboratories, Murray Hill, New Jersey,  
 B. BEDERSON, K. RUBIN, and A. SALOP, New York University

We shall in our remarks stress nuclear polarization though it will become evident that the instrument we will describe can be employed for electronic polarization and hence atomic beam magnetic resonance experiments as well. As is well known a beam of atoms is split into  $(2I+1)$   $(2J+1)$  beams on passing through a magnetic field  $H$  with a gradient  $\nabla H$ . The deflecting force is  $\mu_{eff}\nabla H$  where  $\mu_{eff}$ , the effective magnetic moment of the atom, is a function of  $H$ , the field in the particular region of the gap traversed by the beam. When  $H < \Delta W/2\mu_0$  ( $\Delta W$  is the zero field hyperfine splitting) and  $J \neq 0$ , atoms in different nuclear magnetic substates ( $m_I$ ) have different effective moments of the order of a fraction of  $\mu_0$ . Such an inhomogeneous field is therefore in principle a means of producing a polarized beam as has been pointed out by several speakers before me. In practice the two main difficulties are 1) the deflected beam has many times the width of the original beam due to the thermal velocity distribution, and 2) only narrow beams can be used since  $\mu_{eff}$  is a function of  $H$  and  $H$  necessarily varies across the gap. These (and other) difficulties can be overcome by applying an electric field  $E$  across the magnetic polefaces which must of course be insulated from the magnet yoke. The electric field therefore has a gradient  $\nabla E$  (proportional to  $\nabla H$ ) and exerts a deflecting force  $\alpha E \nabla E$  on an atom with an atomic polarizability  $\alpha$ . By satisfying the balance condition  $\mu_{eff}(m_I)\nabla H = \alpha E \nabla E$  for any particular state  $m_I$ , a beam of atoms in that state suffers no deflection and hence no broadening on passing through the field. Moreover it can have finite width since the balance condition can be satisfied over a wide range of  $H$  by choosing an  $H$  for which  $\mu_{eff}$  is nearly proportional to  $H$ .

The balance condition in the intermediate field region can be satisfied for most atoms (e. g. alkalis) with fields whose gradients are of the same order of magnitude commonly employed in atomic beam experiments (i. e.  $\nabla H/H = \nabla E/E \approx 3 \text{ cm}^{-1}$ ) with values of  $E$  below the breakdown field. For hydrogen whose polarizability is about fifty times less than that of alkalis the situation is unfortunately less favorable and it may be necessary to work in the low field region ( $\mu_{eff} \approx 0.1 \mu_0$ ) in order to satisfy

the balance condition with feasible  $E$ -fields and still retain a favorable geometry and the advantages offered by the  $E$ - $H$  spectrometer. Although it has not been tried it seems likely that the resolution of such a system for hydrogen atoms can be greatly increased by running the hydrogen discharge at a low temperature.

An  $E$ - $H$  gradient spectrometer has been built at New York University and is being used to measure  $\alpha$  of alkalis [1]. Polarized beams with essentially the same width as that of the original beam width and their theoretical intensities have been obtained. This is illustrated in figure 1 where the beam profile of a  $K^{39}$  beam with and without deflecting fields

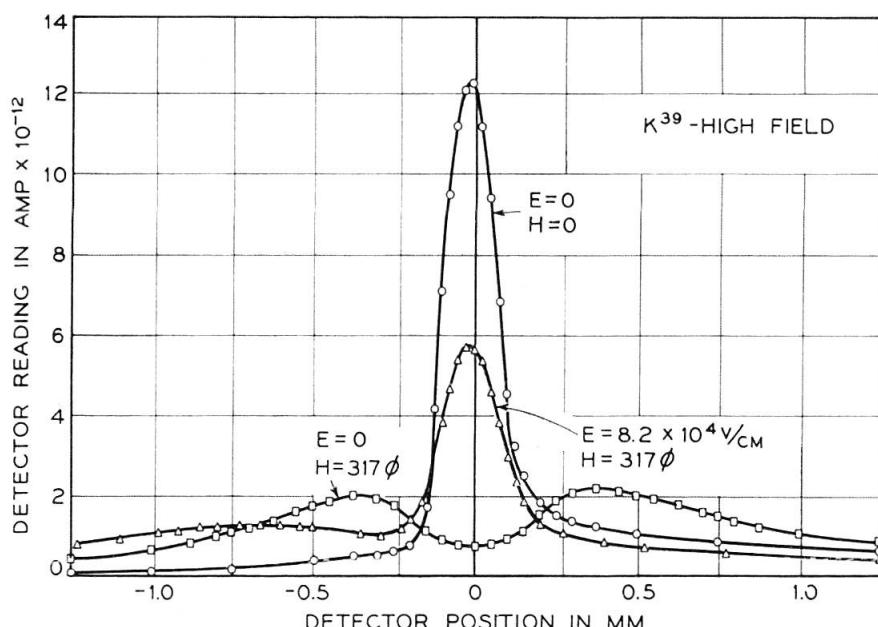


Figure 1

The beam profile of a  $K^{39}$  atomic beam at the detector position with and without applied  $E$  and  $H$  fields.  $\nabla H/H = \nabla E/E = 2.6 \text{ cm}^{-1}$ . Note that the beam width with  $E$  and  $H$  applied is almost the same as the width of the unseparated beam ( $E = H = 0$ ).

is shown. Note that the  $H$  field by itself causes considerable broadening of the deflected beams but that the effect of the simultaneous application of the  $E$  and  $H$  fields is to re-establish the beam width of the undeflected beam.

We have confined our remarks to dipole fields but it can readily be seen that these ideas are applicable to higher multipole fields as well.

#### REFERENCE

[1] A. SALOP, E. POLLACK, B. BEDERSON, and J. EISINGER, Bull. Amer. Phys. Soc., June 15-17, (1960).