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Introduction to BRAG: The Baryon Resonance Analysis Group

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Abstract. The Baryon Resonance Analysis Group (BRAG) was established in 1999 as a network of researchers dedicated to the extraction of resonance information from electromagnetic and hadronic facilities worldwide. This article presents an overview of the group and its activities.

PACS. 14.20.Gk Baryon resonances with S=0 – 14.20.Jn Hyperons

1 Introduction

A few years ago, a group of experimentalists, theorists, and phenomenologists met together and established the Baryon Resonance Analysis Group (BRAG). This group was formed in part because it was felt that a more concerted effort was needed to analyze and extract useful physics from the new N^* data then beginning to become available from JLab, Mainz, Bonn, Bates, BES, BNL-AGS, and other facilities where research on baryon resonances is performed. The operation of BRAG is the responsibility of its elected Steering Committee. The Steering Committee is responsible for scheduling, announcing, and presiding over meetings, and for inviting outside speakers. The Steering Committee also conducts the nomination and balloting process, and serves to maintain the roster and e-mail lists.

According to the group charter, the Steering Committee is responsible for maintaining contact with the individual Working Groups (see Sect. 2) and for soliciting regular updates on Working Group activities and progress every 4-6 months. The Steering Committee also oversees regular dissemination and publication of BRAG meetings minutes and BRAG results, maintenance of the BRAG web site, and contact with experimental collaborations. Finally, the Steering Committee is responsible for the search for external funding for BRAG. The current BRAG Steering Committee consists of Mark Manley (Chair), Bill Briscoe (Secretary), Cornelius Bennhold (Working Group Liaison), and Mauro Giannini (Publisher).

BRAG has four main goals: (1) To carry out a regular review of progress and remaining problems in the field of N^* physics; (2) To carry out a coordinated dissemination of data, existing results, and conventions to assist the field to grow and reduce duplication of efforts; (3) To facilitate the discussion of controversial results, thus allowing important new ideas to be more quickly recognized, and errors to be more quickly corrected; and (4) To initiate studies of problems not feasible for individual researchers. A regular review of progress and remaining problems in the field is needed given the proliferation of new measurements and analyses mentioned in the opening paragraph.

Membership in BRAG is defined as being listed on the membership roster. Those wishing to participate should supply their address and interest lists to the Secretary. No fees are charged and members may withdraw at any time. Voting members must either attend one meeting or respond to one e-mail survey every two years. The most recent BRAG meeting was held on October 8, 2002 at the University of Pittsburgh as a pre-meeting associated with the NSTAR 2002 Conference.

BRAG currently has about 117 members from 52 institutions in 18 different countries. The institutions having the largest numbers of members in BRAG are Jefferson Laboratory and the George Washington University in the U.S., and Universität Bonn and Universität Mainz in Germany. Additional information is available on the group website, http://cnr2.kent.edu/ manley/BRAG.html.

2 Working groups

Working groups are formed between BRAG members with similar interests and common goals in a particular aspect of N* physics. BRAG members may belong to several working groups with overlapping interests. As the field evolves, the interest and the focus of a working group may adjust. A working group exists when at least three BRAG members have decided to collaborate on a particular issue and have notified the Secretary of their intention. Working group membership is open to all BRAG members and exists after it has been reported to the Secretary. One member acts as the main contact or chair.

There are three standard BRAG working groups: (1) Extraction and Interpretation of Resonance Parameters; (2) Partial-Wave Analysis; and (3) Database Issues.

2.1 Working Group on Extraction and Interpretation of Resonance Parameters

The Working Group on Extraction and Interpretation of Resonance Parameters was established to study the extraction and interpretation of resonance parameters within different approaches. One goal is to ascertain the minimum theoretical requirements that different approaches should include. Another question addressed by this group is how should background be separated from resonance contributions. This group also is concerned with the proper way to compare extracted resonance parameters with quark-model results. Its current chair is Cornelius Bennhold of the George Washington University.

One of the projects that this working group carried out was an investigation of nucleon resonance properties in different multichannel analyses [1]. A goal of this work was to study how the extraction of resonance parameters is affected by different methods of separating resonance and background contributions. Three independent university groups (GW-Giessen, KSU, Pitt-ANL) carried out independent unitary multichannel fits and investigated background contributions to selected waves (*e.g.*, S11, P13, P33, D13) by turning off the direct coupling of the resonances to γN channels. One of the results of this study was the identification of a "first tier" of states in which all three analyses agreed with each other at 20-30% level. For pion photoproduction multipole amplitudes, the three different groups found fairly good agreement in some cases (*e.g.,* E_{1+} and M_{2-} proton multipoles for P33 and D13 waves, respectively), but rather large differences for other cases (*e.g.*, M_{1+} proton multipoles for P13 wave).

A natural extension of the work described above and a possible future project for this working group would be for independent university groups to investigate the model dependency of resonance parameters by performing unitary multichannel fits of a specified set of partial-wave amplitudes (PWAs) fitted over a pre-specified energy region. These fits should be limited to the same number of channels and resonances in each partial wave. This working group has also discussed [2] another possible project in which the goal would be to determine a set of *objective* criteria for ranking resonances. This BRAG rating system would replace or augment the scheme used by the Particle Data Group in the *Review of Particle Physics* [3].

2.2 Working Group on Partial-Wave Analysis

The Working Group on Partial-Wave Analysis was established to study the model-dependence of partial-wave analyses or multipole analyses of data associated with the N* program. A goal of this group is to find a set of PWAs that are as model independent as possible. In addition, it seeks to determine the optimum set of experiments necessary to achieve this goal. Its current chair is Ron Workman of the George Washington University.

An important project carried out by this working group was the investigation of the inherent model dependence of pion photoproduction multipole analyses in the low-energy region 180-450 MeV, which is dominated by the $\Delta(1232)$ resonance [4]. Several different groups (GWU, Mainz, RPI, Yerevan, and Kharkov) carried out independent multipole analyses by using a selected benchmark database. From the combined set of benchmark fits, the $E2/M1$ ratio was found to be $-2.38 \pm 0.27\%$. The most important quantity here is the uncertainty. This project also identified a particular data set for neutral pion photoproduction as problematic for all groups. (These data have since been remeasured.)

A possible future project for this working group would be to extend the investigation summarized above to electroproduction. The goal would be to try to understand the model independence of the E_{1+}/M_{1+} and S_{1+}/M_{1+} ratios as a function of Q^2. Another possible project for the future would be for different university groups to carry out unitary, multichannel partial-wave analyses of selected πN elastic and inelastic reactions ($\pi N \to K\Lambda$, $\pi N \to \eta N$, $\gamma N \to \pi N$, *etc.*). This project should directly fit physical observables (*e.g.*, cross sections and spin observables) as opposed to fitting partial-wave amplitudes obtained from single-reaction partial-wave analyses.

2.3 Working Group on Database Issues

The Working Group on Database Issues was established to explore and advance database issues related to N* physics. The ideal BRAG database would contain all experimental data below c.m. energy $W = 3$ GeV and momentum transfer squared $Q^2 = 5$ $(\mathrm{GeV}/c)^2$ using electromagnetic (photon and electron) and hadron (pion, kaon, and proton) probes with hydrogen and deuterium (neutron) targets. Its current chair is Igor Strakovsky of the George Washington University.

A. Bellachia of the George Washington University discussed one of the key projects of this group at the most recent BRAG meeting [5]. The project, now well underway, involves replacing the well-known SAID experimental database (developed at Virginia Tech by R. Arndt and L. D. Roper) with a web-based system (iSAID). While SAID uses "flat files," the new iSAID system uses a Relational Database Management System (RDMS). The iSAID system enhances the older SAID with tools to analyze, search for, and integrate new data. Data representation in iSAID is done with XML: eXtensible Markup Language. This is a flexible, platform independent language that separates content and presentation (somewhat like HTML). Free tools are available for processing and web support.

Two different types of users are expected to benefit from and utilize iSAID: a general user and a data provider. A general user will be able to compare existing data with models encoded into the iSAID system. Built-in tools will allow a comprehensive view of the current status of theory and experiment. The other type of user, a data provider, will typically be an experimentalist with preliminary data who will be able to add data to the iSAID database to allow comparisons between models and existing data. Data

from this source will be private and not accessible to general users. This will also allow exploratory fits before publication.

The present SAID database connects models and data for 10 different reactions (30 reaction subtypes). As of January 2003, data have been transferred from flat files for the 10 reaction types to a single unified RDMS in iSAID. A prototype iSAID is available for testing from the site, http://128.164.158.188/isaid/index.jsp.

3 Summary

BRAG exists as a useful community of experts within the N^* field. All interested physicists (especially junior faculty, postdocs, and students) are encouraged to join and take active roles. Those wishing to subscribe to the BRAG listserver need only go to the site

https://mailer.csit.fsu.edu/mailman/listinfo/brag

and follow the instructions. The BRAG website includes many useful links and webpages, including a frequently updated page with conference links. Members are encouraged to join working groups or start new ones. Ideas for projects are needed and several leadership opportunities are available.

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