Examining D_s^* Decays: The Hunt for Red Omega

Christopher Bush

Department of Physics and Astronomy, Wayne State University, Detroit, MI, 48202

Abstract

It was and is our goal to establish the likelyhood of a specific decay of the D_s^* meson into a D_s γ combination of a lepton, hadron, and neutrino. To this end we wrote a program to look through previously obtained Monte Carlo data and put together the combinations we were looking for. Once we decided on specific cuts to make on all the data that maximized the signal-to-background ratio, we ran our code over the actual CLEO II data to see if the decay modes we were looking for were actually there. These modes were $D_s \longrightarrow$ l, (ω, η, ϕ), ν.

Introduction

The D_s meson has been measured for years, and has been seen to go into numerous decay modes. In particular, the leptonic and semileptonic modes have been measured before. What we were and are trying to do with this experiment is show that there is another decay mode that has not yet been measured; one that is a leptonic mode. The D_s has been shown when going into a leptonic/semileptonic decay to decay approximately 2% of the time into l, ϕ, ν as well as l, η, ν. Our goal is to show that the D_s meson when going into a leptonic/semileptonic decay mode also goes into l, ω, ν a comparable amount of the time. To that end we've spent a lot of time preparing code to run through sets of events and look for particular combinations; the ω combination as our goal, as well as the ϕ and η combinations as controls. What we want to have happen is events where the D_s goes into ω fill a histogram that plots the mass of the D_s and similar mass plots for the η and ϕ modes. We then want to compare and show that the ω is indeed comparable. We believe that demonstrating this decay mode is something that has not yet been done.

Method

The first step in an analysis of the CLEO II and II.5 data like this was to set up the code that is going to look through the data for you. Since the CLEO II and II.5 data was taken in the 1980's and early 1990's, the code that has been written by a large number of people to enable us to look through everything was all done in Fortran 77. The porting of all the Fortran 77 code to C++ has not yet been completed to the point where it was an option for us, so our code had to be done in Fortran. The initial part of getting our software together was done in the conference room, where several selection cuts were proposed and decided upon as first efforts. It was necessary then to test these first efforts on Monte Carlo data in order to refine them and determine if they were the best cuts to find what we were looking for.

In order to test our first efforts we had to produce Monte Carlo data files to run the cuts over. To be sure that we'd be able to see what we were looking for we produced Monte Carlo signal (specifically what we wanted) as well as Monte Carlo background (anything at all) and then compared the two to give us a signal vs. background ratio.

After massaging the first efforts and getting a look at how much signal we were getting compared with the background we made changes to the cuts were made, proposed new cuts, and the cycle started again. Eventually a set of cuts were chosen and the code simplified and finalized to accomodate this. Once this was done, the CLEO II and II.5 data had to be put into a file format that our run scripts were able to read. After data production had finished, we ran our final cuts over the actual data and to see what we could see.

Results and Histograms

Our initial runs over the Monte Carlo data gave us hope that we would see the ω show up in the mass of the D_s when we did the reconstruction. This was not the case however, after we compiled the data files from CLEO II and II.5 and ran over this data. After reconstructing the ϕ within the mass of the D_s relatively well, we should have been able to see the ω if it was there. After the runs finished and the histograms were filled, however, we did not see precisely what we needed to enable us to say we demonstrated the presence of the ω. What we did see was encouraging, and the following histograms will show what we think our peak should have looked like as well as what we actually saw. I will use the ϕ reconstruction to demonstrate what we were hoping for, and then show the ω which goes into three π for a comparison, as well as the η that goes into two γ, as well as the η that goes into three π. More work must be done on these last three to clean them up so they look comparable to the ϕ combination plot.

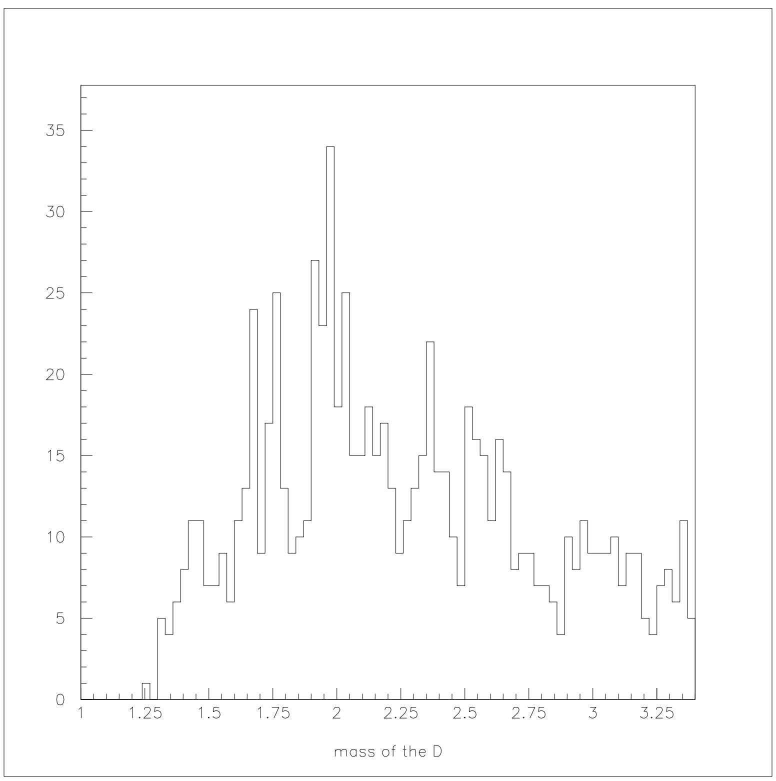

FIGURE 1. This is the mass of the D_s as reconstructed with the ϕ l ν configuration which we used as a control to compare with the ω.

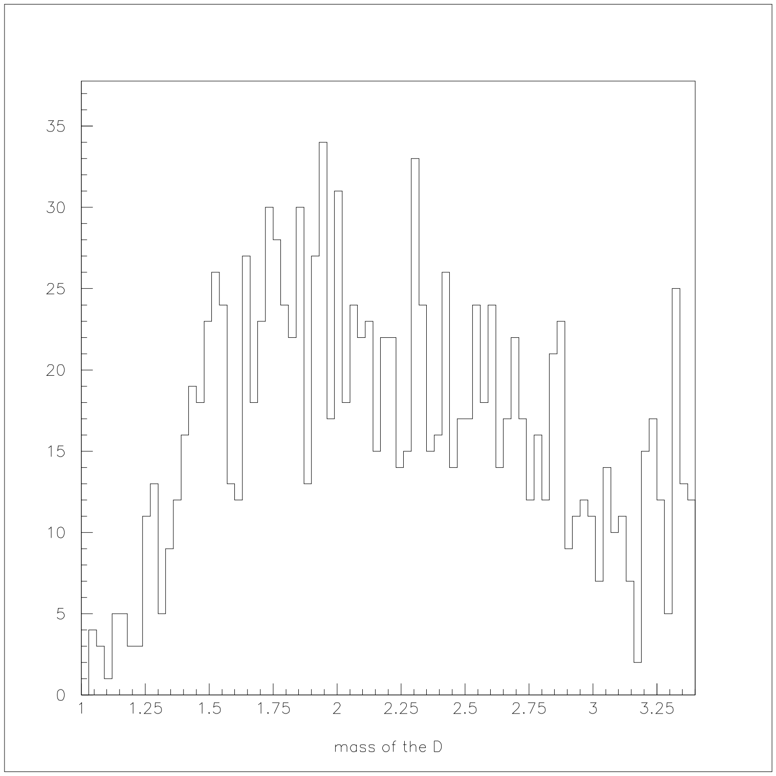

FIGURE 2. This is the mass of the D_s as reconstructed with the ω l ν configuration. It shows that we need to clean up the cuts a lot.

Conclusions

It would be nice to be able to say here that we found the D_s^* that goes into D_s that goes into a lepton, neutrino, and an ω particle, but that is not the case. Having done a reasonable reconstruction on the ϕ decay of the D_s, we expect that we would have been able to see the ω decay if it was there. We did see something encouraging, but that does not mean that it is there nor that it isn't there. We have yet to come up with an efficiency on what we looked at, and we should be able to at least come up with an upper limit for this as well, regardless. That remains to be done, as well as cleaning up what we have done so that we will be able to say with conviction that D_s does or does not go into a lepton, neutrino, and ω particle. When all the work is done on porting the Fortran 77 code for CLEO II and II.5 into C++, it would be nice to redo what we've done in C++ if we show any promise with the ω between now and then.

We need to take a few more hard looks at how we're choosing and making our cuts as well as spend time making sure that the code is doing what we want. There remains a lot of work to be done on this particular project, which I will continue to assist Professor Bonvicini with over the next year. Hopefully we will get some definitive answers one way or the other on this, but more especially we hope that we do indeed find the ω decay. This was an interesting project, in the sense that I learned a lot about programming and high energy physics at the same time. I wish that we could have come up with conclusive answers to our

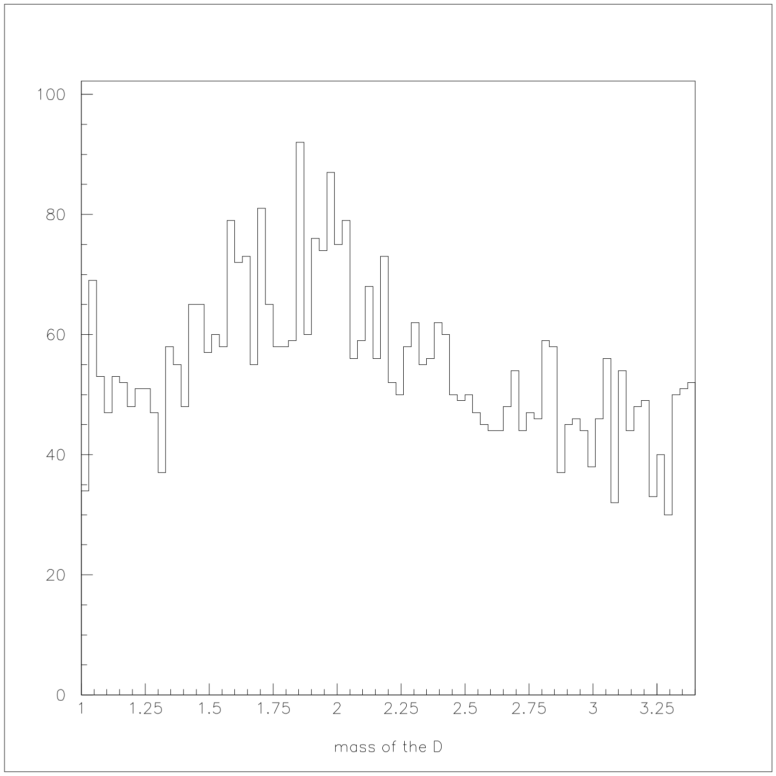

FIGURE 3. This is the mass of the D_s as reconstructed with the η l ν configuration, which we also used as a control.

question during the 10 weeks of the REU, but I have no regrets about the project at all and look forward to continuing work on it in the fall. Here you describe your conclusions. This can include a discussion of what remains to be done and how one might go about doing it.

Acknowledgments

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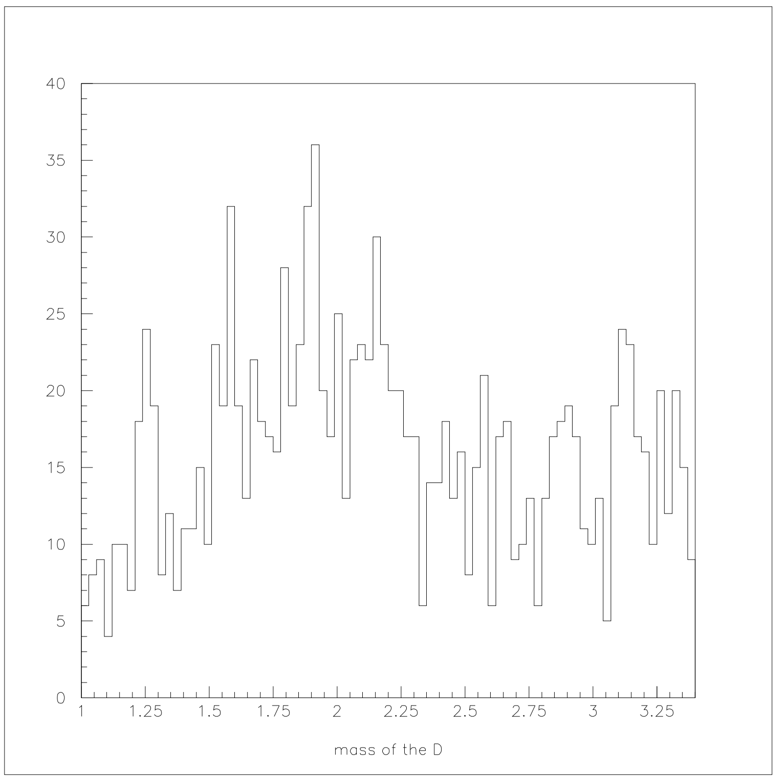

FIGURE 4. This is the mass of the D_s as reconstructed with the η l ν configuration, yet another control comparison.