Tapestry of Field theory: Classical & Quantum, Equilibrium & Nonequilibrium Perspectives

Prof. Mahendra K. Verma

Department of Physics

Indian Institute of Technology, Kanpur

Week - 11

Lecture – 66

Now, we need to do the noise, noise renormalization. I am doing only scarcarily I mean for details you need to look at the paper. So we have 2 h, h k omega and we write as h is Green's function times noise. So Green's function times noise and Green's function times noise, noise is cross and cross cross multiply and that gives you D. So this is the full Green's function, but look now h is at a big small way numbers so or large scale. So, I can also expand h.

So, the idea is that we expand h. So, the idea so what we do is we write so this is standard g. So, we have h is g then we write so look I have look at the non-linear term now. So, h equal to noise h of k hat is noise k hat.

Green's function also I need to put Green's function in first. The G inverse is in the left so that will go to right G naught of k hat then we have noise plus non-linear term lambda h h 2h. So I expand it so I have this Green's function and 2 non. So the two leading order we write this as this h one of the h, one h will come from the right.

So, let us write the first one. This one and from the right it comes that. So, this is a standard one which will G naught and D right. Noise will give D right noise squared is D, but we go to the next term which will be this G naught then this 2h and from this side also 2h like that got it. Now one every h now we write as a noise times G naught times noise.

So, we have this the noise times this, this, this, this and that. So, we have four Green's function here inside. By the way these Green's functions will be outside. So if you look at D this is the original D now I get a correction from here. So there how many D's are there? The four noise right.

Four noise will give 2 D squared, this will give 1 D and this will give 1 D, D squared and there are four Green's function right. There is a Green's function, Green's function, Green's function, Green's function. So, I think I have the expression here which I am just going to show. So we have four Green's function, these are four Green's function 1, 2, 3, 4. So this like G naught p, G naught p here and G naught q, G naught q here and D here so this is D squared and 2 vortex lambda lambda lambda squared.

But look Feynman diagram is nice that way I do not need to write it beforehand I just draw the diagram then I do the calculation. And we do the integral. So this is a so you can see there is a correction in this D tilde new noise which is D plus D squared and some coefficients. Now this calculation can be done I mean if you are patient then you can do it no problem. Then this is what we get for after coarse graining.

But then I need to also apply this rescaling right that is another part. So I need to apply rescaling and the pre factor for the noise was this. These are rescaling part. So overall I get that. So this factor is coming from this is the G well this okay no no so not yet.

This is this part is only for rescaling but d less I am going to substitute from here. So this D less. So I will get one part from here and other part from here and that is that. So this one rescaling and this part from here from coarse graining. Got it? Well the idea is clear no.

So we need to do both coarse graining and rescaling for KPZ. Now it turns out for vortex renormalization the Feynman diagrams look like that. It looks pretty cranky no. What is this diagram this called vortex diagrams. Vortex correction actually vortex correction.

That this is in particle physics is one of the major things like coupling constant is vortex. So I am just going to make one I will show you how to do which one this one. So look at this we have this vortex and 2h right 2h. So what I will do is I will make 1h as a Green's function and so remember h was if you put the nonlinear term Green's function and 2h. So we rewrite this as only this part I am writing here.

So this h becomes Green's function and 2h like that. Now bottom one also I do the same thing. Green's function and 1h and 1h. Now this h is Green's function and noise. So you rewrite this.

So this guy Green's function and noise Green's function and noise and this is that. So these are the two arrows. These are two arrows. This arrow is this arrow. This arrow is this arrow and this arrow is coming from the left.

This is the this arrow I feel like this arrow and this is my vortex correction triangle. So this is that picture. It turns out in normal field theory solid line is same as Green's function. But I tend to write wavy thing for Green's function but they write in fact in this convention solid line is also Green's function. But I would like to contrast it here.

Is that clear I mean. So you can also write down for other two. And it turns out you can do the calculation and these guys give you 0. In fact you can do the calculation to 0 to first order it is 0. So no correction in lambda. It is a difficult calculation but it can be done.

It has been done by these authors. And this is a nice book Barabasi and Stanley. So there all these steps are done in PRL, short paper and steps are skipped. But Barabasi and Stanley has done all these steps. It turns out coarse graining has no contribution only rescaling and contribution for lambda.

And so that is the equation. So it is only rescaling you know there is no g squared. g squared is the strength of well that is the term right lambda squared d by nu cube. But there is no g squared coming here. Whether g squared is not strength of the coupling.

They call it coupling but the coupling is lambda for me. But in the nonlinear strength of in that viscosity correction this is g squared. Now if you put all these three equations then I get these three equations. I am just rewriting it here. Nu equation, d equation and lambda equation.

I did show you how to get them. Now we know what is g squared. g squared is lambda squared d by nu cube. So I can write down what is dg by dl. How does this this g change with l? So g is the strength of the nonlinear term in some sense in coarse graining and rescaling.

Okay. So remember this was the thing which came in this correction. Also it came in a viscosity a noise correction. This is a new correction and this is a noise correction. It turns out well I will skip the algebra now.