KOLKATA WEDNESDAY 15 FEBRUARY 2012

Where bubbly gets its fizz

Tracing the sparkle in a champagne glass is heady fare, says

s ananthanarayanan

MICRO-PHOTOGRAPHS of rising bubbles brighten the latest work of Gérard Liger-Belair, Professor of Physics at the Laboratory of Oenology at the University of Rheims, in France's Champagne district. The piece, *The Physics behind* the Fizz in Champagne and Sparkling Wines, in the current issue of the *European Physical Journal*, follows *Uncorked*, his 2004 book, which won the award for "Best Professional/Scholarly Book in Physics

Publishers and also the 2005 Gourmand World Cookbook Award for "Best Book on European Wine" Liger-Belair uses physics, chemistry and high-speed photography to study the science behind the picturesque bubbles that rise as champagne is

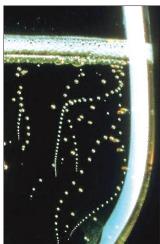
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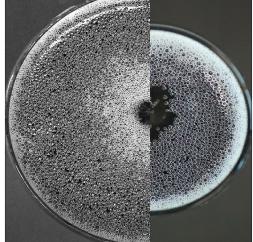
poured. The science of champagne itself, as of wines in general, is well understood but the mystery of the geometric, floral and even night-sky patterns formed by the bubbles that rise — now quickly, now slowly — in a freshly poured glass has remained unclear. The "oenology and applied chemistry" lab at Rheims, right within France's champagne-producing districts, has been working to understand the mechanics of the champagne bubble, the discovery of which could have uses in other fields.

All wines are the juice of grapes, whose sugar content has been converted into alcohol by the action of yeast. Different strains of veast produce different families of alcohols and other "cogeneration" to yield characteristic flavours. The yeasts are native to the grape that grows in different districts and, hence, the character of wines that are named by the place of origin. But champagne and other sparkling wines have an added load of carbon dioxide, which gives them an extra tang and also the visual effects as the gas leaves the wine in streams of bubbles.

The wine in Champagne in carbonated through a process attributed to Dom Perignon, a 17th century monk and cellar-master in the abbey at Hautvilliers, a village in north-east France. In the production of wine, a colony of yeast is first added to fresh grape juice, which has about 12 per cent of sugar content. As the yeast attacks the sugar to form alcohol and carbon dioxide, it takes the help of dissolved oxygen in the juice to multiply some millionfold. As soon as there is a good population of yeast, the juice is closed to fresh access to oxygen through an air lock, which lets out the CO₂ , and the yeast devotes itself to sugar-conversion till all the sugar is

And along the way, the exhausted yeast, as well as fresh yeast. settles to the bottom of the container and the clear wine is decanted. This is important, as leaving the yeast in the wine creates unpleasant flavours and visually disturbs the clarity of the wine





In the case of champagne, dead yeast would be a double disaster as the debris, or "lees", would rise and cloud the wine as soon as the carbonated bottle is opened. Again, as some yeast cells get created in the next process of making sparkling wine, these need special treatment. The next process, which is after the sugar has fermented and the clear wine drawn into bottles, is that another charge of sugar is added to the wine and the bottle is corked. As

of dead yeast and is also carbonated

The level of alcohol in the wine and the extent of the second fermentation are controlled so that there is around five litres of CO₂ dissolved in a 0.75-litre bottle of champagne. This is the gas is released, some 20 million bubbles, when the cork is opened. The bubbles stay in solution when the cork is there, because of the

pressure. This, again, is the reason that champagne bottles are sturdy, to withstand pressure. When the pressure is

there is some yeast, this new

sugar also ferments, with the difference that the bottle is

corked and the CO2 stays and

carbonates the wine. But the

trouble is that this second fermentation again produces

dead yeast cells and "lees" which need to be gotten rid

by Dom Perignon, this is managed by keeping the bottles with the corks

downwards, during the

second fermentation.

of. In the process discovered

The lees thus collect in the

neck of the bottle, at the cork.

When the fermentation is

over, the wine at the neck is

frozen solid, so that the cork can be removed without the

wine or the gas escaping. The lees are then cleaned, topping

up the loss with some fresh

wine and the bottle is corked again. The wine is now clear

released, the gas bubbles out, like in the case of boiling. But just like boiling, the bubbles need to form first as very small bubbles before they rise and burst at the surface. But very small bubbles have to form at very high pressure and in the case of pure water, which is protected from particles of dust, boiling may not set in at a

temperature well above its boiling point.

In the case of champagne that has been popped, too, there is the need for tiny "points of nucleation", which may be imperfections in the glass or specks of lint or dust that allow the first bubbles to form. And then, research shows, the nature of the bubble release depends on factors like the alcohol and carbonation levels, temperature, salts, carbohydrates, minerals and other components of the wine. Gérard Liger-Belair took high-speed micro-photographs of bubbles to stretch out the stages of their short lifespan to analyse the forces at work. "Fibres entrap a tiny air pocket when

champagne is poured," he says.

"Then, this tiny air pocket literally sucks the carbon dioxide" from the surrounding wine so that the bubble grows till it lets go the fibre to rise to the surface. As it rises, it draws in more ${\rm CO}_2$ and also swells with reducing depth, and bubbles race apart. The speed of bubble growth falls with the level of carbonation, which again changes the distance between bubbles. And the bubbling creates currents within the wine and bubbles may swerve and spiral or merge and deflect!"

Apart from their fleeting rise from the point of arising to the surface, the bubbles again express themselves when they burst. When they burst, they spray liquid jets that break up into microdroplets of wine and create a mist of aromatic substances that are released into the bubbles at the bubble-wine interface. Close observation reveals that the bubbles form at the surface as a raft in a hexagonal pattern, with bubbles moving and jostling to take the place of one that has burst Gérard Liger-Belair's work into the detailed study of the mechanics of sparkling could help create better wines, as the connoisseur view is that smaller bubbles make for a better quality of champagne. "Today, it is not yet possible to control the bubble size," says Liger-Belair, "except by diminishing CO₂ content, which is obviously not legal." But the study may help vineyards get there.

In the words of Professor Richard N Zare of Stanford, who

reviewed the book Uncorked in the journal Nature and conducted trials on Californian wines, "Our thirst for knowledge is still not

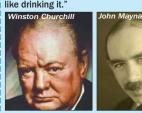
The writer can be contacted at simplescience@gmail.com



The popping of a champagne cork compared with an atomic blast at Nevada.

Witticisms inspired by champagne

WINSTON Churchill: "Meeting Franklin Roosevelt was like opening your first bottle of champagne; knowing him was





champagne.

Deathbed



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Prepaid tariff plans

									-		Tariff	Plan Titl	es (#)											
Particulars/Services	Details	FRC 21 (WB)**		FRC 37 (Kolkata & WB)		FRC 56 (Kolkata)		FRC 56 (WB)		FRC 57 (Kolkata & WB)		FRC 86 (Kolkata & WB)		FRC 101 (Kolkata)		FRC 101 (WB)		FRC 151 (WB)**		FRC 201 (Kolkata)		FRC 201 (WB)		
One time charge, if any		₹21		₹37		₹56		₹56		₹57		₹86		₹101		₹101		₹151		₹201		₹201		
Free calls/SMS/ data transfer, if any (included in one time charges)		TT- ₹15 in Main A/c. Validity: Lifetime		TT-₹37 (Talk Time Validity: 30days), Product Validity: Lifetime		TT-₹50 in Main A/c. Validity: Lifetime		TT-₹50 in Main A/c. Validity: Lifetime		TT-₹50 in Main A/c. Validity: Lifetime		TT-₹80 in Main A/c. Validity: Lifetime		1000 Idea to Idea local mins & 300 Idea to other local mins (calls to local landline excluded) for 30 days. Product Validity: Lifetime		1000 idea to idea local mins & 300 idea to other local mins (calls to local landline excluded) for 30 days. Product Validity. Lifetime. During peak hours (5pm to 10pm). All local calls will be deducted from ICD bucket and ICI free mins cannot be used. Also local calls made from ICR sites will be deducted from ICR sit		1400 Idea to Idea local mins & 400 Idea to other local mins (calls to local landline excluded) for 30 days. Free mins not applicable in ZG ICR regions of WB. Product Validity: Lifetime		2000 Idea to Idea local mins & 700 Idea to other local mins (calls to local landline excluded) for 30 days. Product Valldity: Lifetime		2000 Idea to Idea local mins & 500 Idea to other local mins (calls to local landline excluded) for 30 days. Product Validity: Lifetime		
3. SIM/Account Validity		NA		NA		NA		NA		NA		NA		NA		NA		NA		NA		NA		
4. Tariff Validity (initial/promotional/base)		180 days		180 days		180 days		180 days		180 days		180 days		180 days		180 days		180	180 days		180 days		180 days	
5. Pulse Rate																		1 second		1 second		1 second		
6. Call Charges (initia	/promotional/	base, if any)									-1												
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Local	On net	First 6 months: 40p, then 50p	NA	First 6 months: 40p, then 50p	NA	First 6 months: 40p, then 50p	NA	1st month: 10p, next 5 months: 40p, then 50p	NA	1p/sec	NA	1st month: 10p, next 5 months: 40p, then 50p	NA	1p/sec	NA	1p/sec	NA	1p/sec	NA	1p/sec	NA	1p/sec	NA	
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	Mobile/Fixed(*)	First 6 months: 40p, then 50p	NA	First 6 months: 40p, then 50p	NA	First 6 months: 40p, then 50p	NA	First 6 months: 40p, then 50p	NA	1p/sec	NA	First 6 months: 40p, then 50p	NA	1p/sec	NA	1p/sec	NA	1p/sec	NA	1p/sec	NA	1p/sec	NA	
STD	On net	First 6 months: 40p, then 50p	NA	First 6 months: 40p, then 50p	NA	First 6 months: 40p, then 50p	NA	First 6 months: 40p, then 50p	NA	1p/sec	NA	First 6 months: 40p, then 50p	NA	1p/sec	NA	1p/sec	NA	1p/sec	NA	1p/sec	NA	1p/sec	NA	
	Off net	First 6 months: 40p, then 50p	NA	First 6 months: 40p, then 50p	NA	First 6 months: 40p, then 50p	NA	First 6 months: 40p, then 50p	NA	1p/sec	NA	First 6 months: 40p, then 50p	NA	1p/sec	NA	1p/sec	NA	1p/sec	NA	1p/sec	NA	1p/sec	NA	
	Mobile/Fixed(*)	First 6 months: 40p, then 50p	NA	First 6 months: 40p, then 50p	NA	First 6 months: 40p, then 50p	NA	First 6 months: 40p, then 50p	NA	1p/sec	NA	First 6 months: 40p, then 50p	NA	1p/sec	NA	1p/sec	NA	1p/sec	NA	1p/sec	NA	1p/sec	NA	
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	Local	₹1 (for lst 2 months: Every day lst 3 Local/National SMS@60p/SMS, next 100 Local/National SMS@10p/SMS for the day; Next 4 Months:60p/SMS)		₹1 (for 1st 2 months: Every day 1st 3 Local/National SMS@60p/SMS, next 100 Local/National SMS@10p/SMS for the day; Next 4 Months: 60p/SMS)		₹1 (for 1st 2 months: Every day 1st 3 Local/National SMS@60p/SMS, next 100 Local/National SMS@10p/SMS for the day; Next 4 Months: 60p/SMS)		₹1 (for 1st month: Every day 1st 3 Local/National SMS@60p/SMS, next 100 Local/National SMS@10p/SMS for the day; Next 5 Months: 60p/SMS)		₹1 (for 1st 2 months: Every day 1st 3 Local/National SMS@60p/SMS, next 100 Local/National SMS@10p/SMS for the day; Next 4 Months: 60p/SMS)		₹1 (for 1st month: Every day 1st 3 Local/National SMS@60p/SMS, next 100 Local/National SMS@10p/SMS for the day; Next 5 Months: 60p/SMS)		1st 6 months: @ 60p/SMS, then ₹ 1/SMS		1st 6 months: @ 60p/SMS, then ₹ 1/SMS		1st 6 months: @ 60p/SMS, then ₹1/SMS		1st 6 months: @ 60p/SMS, then ₹1/SMS		1st 6 months: @ 60p/SMS, then ₹ 1/SMS		
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9. Special benefits, if any		NIL		NIL		NIL		NIL		NIL		NIL		NIL		NIL		NIL		NIL		NIL		
10. Recharge/other condition, if any		₹ 200 in every 6 months		₹ 200 in every 6 months		₹ 200 in every 6 months		₹ 200 in every 6 months		₹ 200 in every 6 months		₹ 200 in every 6 months		₹ 200 in every 6 months		₹ 200 in every 6 months		₹ 200 in every 6 months		₹ 200 in every 6 months		₹ 200 in every 6 months		

(#) The term tariff plan will have the same meaning as contained in the unique numbering guidelines issued vide TRAI letter No. 301-31/2008-Eco. Dated 8th April 2009 and FRC 21 to FRC 201 columns are illustrative and can be added as per the requirements/(*) As applicable e.g., whether from fixed to mobile or mobile to fixed.





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