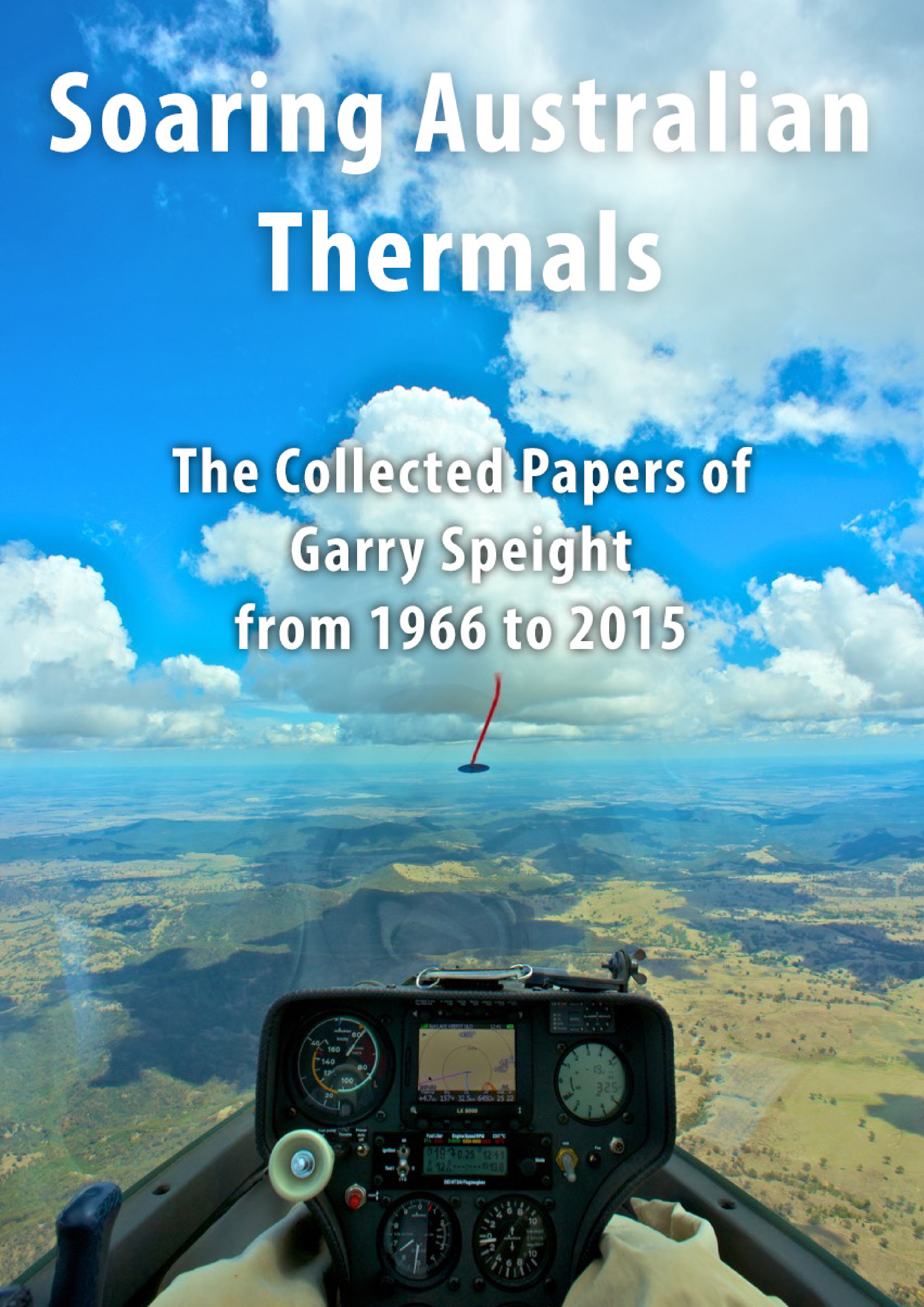
Soaring Australian Thermals

The Collected Papers of Garry Speight from 1966 to 2015



Letters to the Editors: Rotating Thermals

Although I would have liked to see more discussion of rotating thermals, the topic attracted these seven replies.

From Allan Ash

Originally published in Soaring Australia, July 2006

The article 'Thermals that rotate', by Garry Speight, Soaring Australia, May '06, brought to my mind something that has puzzled me for years.

During 1949 I was a member of the London Gliding Club in Britain and I carried out a number of thermal flights in Grunau Baby and Slingsby Prefect sailplanes. I found that I could circle quite comfortably to the left (anti-clockwise and in the direction of thermal rotation) without any special concentration, but when I circled to the right I found I needed a bit of extra concentration to maintain the correct speed, angle of bank and nose position.

I put this down to the fact that I was, at that time, a relatively inexperienced soaring pilot.

On my return to Australia in 1950 I found that I could now circle quite comfortably to the right (again, in the direction of thermal rotation) but needed a bit of extra care in circling to the left! Any relaxation of this care resulted in fluctuations of airspeed or nose position. The extra care did not result in any great trauma, but it was noticeable.

As a result, whenever I encounter a thermal I now choose to turn to the right, and if this takes me out of the best lift, I simply adjust the circle until I am centred properly. I make left turns in thermals only on rare occasions. Strangely enough, making left turns at other times, such as in the circuit, don't bother me at all.

Do other pilots have this or similar troubles? Is there something wrong with me? Am I perhaps imagining it all? Do pilots from north of the equator, when soaring in Australia, encounter similar experiences?

If it is of any significance, I am normally right-handed, though there are some things that I do left-handed, such as operating my computer mouse. Does any of the above information have any significance on Garry Speight's excellent teaching?

Rotating Thermals

Kingsley Just

Originally published in Soaring Australia, October 2006

In June's Soaring Australia, Garry Speight proposed a theory as to why sometimes pilots report a particular direction of turn in a thermal as being more comfortable than the other. I do not dispute that this phenomena exists, but I think his theory and reasoning is wrong as to why it occurs, I would hate to think that an untested theory is assumed to be correct, and accepted by the gliding community. I was hoping that someone else more concise with arguments would send in a letter, but none have come so far; so I guess I'm it. I'll do my best to outline my arguments in non-mathematical logic that will hopefully be easy to understand. Hopefully this will catalyse a better explanation.

Let's start with a few assumptions: that the glider's angle of bank does not change; that its airspeed remains constant at a safe margin above the stall for the given angle of bank, flaps, weight and atmospheric combination; and, for argument's sake, a 45° bank angle and 50kt airspeed. The tornado-type model of the rotating thermal as described by Garry is also assumed.

Garry's argument seems to fail when he starts to confuse ground speed with airspeed. To achieve a climb, the glider pilot is only concerned with how small his or her turn radius is within a volume of rising air. It is what you can do in that given volume of air that counts. The ground speed is irrelevant, and in fact has no effect on the radius of the turn. Garry states that it is the "ground speed that decides the rate of turn and the radius of the circle." This is wrong; it is the airspeed and angle of bank which dictates the rate of turn. IFR pilots deal with this every day, and adjust speed

Letters to the Editors: Rotating Thermals

and bank angle (and therefore rate of turn) to allow for wind effects to make good a track along the ground. For example, a 'Rate 1' turn is 180° in one minute. The IFR pilot knows that with a strong wind, a Rate 1 turn will still take two minutes to fly a 360° orbit.

A turn is achieved by the centring force which is derived by angling the lift force towards the centre of the circle. This lift force is generated by airflow over the wing of the glider. No matter what the ground speed is, extra force cannot suddenly be generated out of the air at a given airspeed and bank angle, in order to make the circle bigger or smaller.

So let's get back to fun flying - that is, of course, gliding. Let's assume we are in heaven, perfectly centred in one of these rotating thermals, and hopefully climbing like a homesick angel. Well also assume three constants: the speed of rotation of the thermal for our circle, our airspeed, and our bank angle. We turn through 360° in one minute in nil wind. For this thought experiment, we have a balloon which is neutrally buoyant. We drop this balloon to mark out where the circle starts in this parcel of air. In one minute we arrive back at the balloon; we have turned a perfect circle in this volume of air, and have traced a perfect circle along the ground.

Now let's rotate this thermal, and fly against its direction of rotation. We are still indicating the same airspeed and angle of bank. We drop this balloon again in the rotating thermal. We arrived back at the balloon, having completed a circle in one minute in this volume of air. But where is the balloon in reference to the ground? Yep - it has moved along the ground. We have in fact only flown part of a circle along the ground in the minute, despite having arrived back at our balloon. As you can see, the radius along the ground is the same.

The opposite occurs if we fly with the rotating air. We drop our balloon and in one minute arrive back at it; but with reference to the ground we have completed a bit more than a full circle. In the given volume of air our airspeed, angle of bank, radius and rate of turn is the same. We still get to the balloon in one minute.

Another way to look at this is to experiment with two sheets of tracing paper and a pen. The first sheet is our thermal. Mark the start, and draw a circle on it. Imagine it takes one minute to draw the circle. Now with the second paper beneath (representing the earth) mark the start of the circle on both pieces of paper by pressing hard with your pen. Both pieces of the paper have marks where we started the turn. Draw the circle, again taking one minute, but rotating the tracing paper (thermal) a bit. The radius of the circle is the same, but you have arrived at a different spot on the earth in the minute it took to draw the circle.

I think I have shown by simple examples that ground speed has nothing to do with either the radius of turn in a rotating thermal or the reason that it seems easier to fly against a rotating thermal. This was a fundamental assumption in Garry's explanation of the phenomenon.

It can be easy to find holes in theories, but it takes courage and a lot of thought to put your ideas out there for people to take shots at. For this I applaud Garry for his work and ideas, and hope he will continue to contemplate the mysteries of gliding. My feeling is that an explanation will be found when we investigate instantaneous effects on airspeed as we fly through different circular wind velocities in thermals in an circular path which is non-centred due to inertia or wing loading - something like continuous wind shear, except in the turning plane. (I hope you followed me on that one.) I would be interested to know if hang gliders experience this phenomenon as much as the heavier sailplanes, as that would be supporting evidence. On the other hand, it might be that it is easier to fly into the wind due to the effect on the glider's stability and performance, enabling the pilot to fly at lower speed for a given angle of bank and to circle tighter. I also wonder how we could test such theories.

This is one reason I love aviation: even in 2006, we still do not fully understand the place we play.

Author's reply:

I am sure physics is on my side. I explained it in my article twice: once in a hand-waving way in the text, and once more rigorously in the Notes... If we get a debate going, I think heavy-weights will come out on my side.

On Kingsley Just's letter

Michael O'Brien

Originally published in Soaring Australia, December 2006

I have just read Kingsley Just's letter (October issue, Soaring Australia), and I am on Garry Speight's side.

Kingsley's talk about rate one turns is just an irrelevance. I doubt IFR pilots are better placed to understand this, flying around inside clouds or in the dark! But any glider pilot who has thermalled down low on a windy day should have worked it out: A steady wind, moving at a constant speed, AND IN A CONSTANT DIRECTION, will not change the duration of the turn for a given speed and a given angle of bank. As long as you just fly by horizon attitude, it is easy to maintain constant speed, attitude, and angle of bank. If you look down, there are confusing visual effects as you seem to go much faster downwind, and much slower into wind. This can be particularly confusing if you are in mountainous terrain, with no clear horizon reference. This is all pretty well known and understood, and was done to death in this magazine many years ago. But it is irrelevant to what Garry's article is about, which is where the wind changes in direction around the circle.

A nice way to test arguments is to take them to extremes, and see if you can break them. If a glider was thermalling at 50kt and 45-degree angle of bank, and pointed into a thermal rotating at 50kt, how long would it take a turn? Think before reading on...

I hope you all worked out this is a trick question. You might have concluded the glider would stay still over one spot. However it would not need any angle of bank to do so, it could just fly straight ahead!

Now the diameter of the circular 'streamline' in which the glider is 'hovering' could really be any number. If it was on the edge of a cyclone, it might be a 100km, say. If you dropped a balloon, it would take a long time to come back to you. However, if it was smaller, let's say the top of a tornado, it would come back faster.

Let's assume the glider is flying along a streamline with a circumference of 1.667nm. How long would the balloon take to come back?

The answer is 1.667nm/50nm per hour = 0.0333 hours, which is two minutes. So according to Kingsley's balloon argument, the glider is doing a rate one turn and it is not even turning!

But really it is the balloon that is doing a rate one turn (in the opposite direction), and it has zero airspeed!

If you want something serious, read the technical notes of Garry's article in the June 2006 issue. They are very clearly and beautifully presented. However, if you prefer the absurd try this one:

A pet shop owner has to deliver a three-tonne load of budgerigars, but only has a one-tonne ute.

If he builds a large lightweight cage, and places a cat in the bottom to make sure the budgies do not land, can he transport these without damaging the springs on his ute?

Advanced questions:

1. Does it make any difference if the cage is totally enclosed, as opposed to made of mesh?
2. What should he say if he is pulled over by a transport inspector?
3. If the budgies all circle in one direction, will it make his steering pull off to one side?

Rotating Thermals I

Hans Gut

Originally published in Soaring Australia, December 2006

When I read the 'Letter to the Editors' of Kingsley Just in the October 2006 edition, I was compelled to analyse the articles of Garry Speight about the subject in more details and respond to it.

Part I: Do thermals rotate?
Pages 28 and 29 in the May 2006

Edition There is no doubt in my mind that some thermals do rotate. In fact I believe that all thermals rotate, except, maybe, the bubbles of rising hot air, which have completely separated from the ground.

It is the same effect as when pulling the plug in the bath tub. The direction of rotation depends on small disturbances when the air leaves the ground.

So I agree completely with Garry's Part 1.

Part 2: What they are like.
Pages I to 3 in the June 2006 edition

When I first read Garrys' article then, I did not go through the trouble of checking all his formulas he used to calculate the effect of the rotating thermal on the turning radius. But it certainly made sense to me. And I have found out since, that by changing the direction of turning in some difficult-to-work thermals that it can make a big difference.

When checking the calculations about the turning radius at 50kt with a banking angle of 45-degrees, I arrived at the same result.

As shown in Figure 2.1 in Garry's article: The turning radius, when circling with the thermal which is rotating with 10kt, is 90m compared to 40m when circling against the rotation. But this is only correct if the rotating speed of the air is the same at 40m radius as it is at 90m radius. But this is not likely being the case, because at a radius of 90m the glider is most probably flying outside the core. So the glider will be circling with a somewhat smaller than 90m radius. However, the principle is correct. Now, back to Kingsley's letter in the October Edition.

He does not believe that the ground speed has any effect on the turning radius in a rotating thermal. He is right and wrong. Because, as Garry explained, the angular velocity determines the turning radius when flying with a fixed airspeed and a fixed bank angle. And the angular velocity of the glider in a rotating thermal happens to be identical to the ground speed on a calm day only. Therefore, the ground speed should probably not have been used at all for the explanation. The angular velocity remains the same whether it happens on a windy or on a calm day.

I'm sure that most people will agree with Garry's article, which is most likely the reason why nobody has responded before Kingsley did.

Rotating Thermals II

Jim Grant

Originally published in Soaring Australia, December 2006

With reference to Kingsley Just's letter in the October edition of Soaring Australia about Garry Speight's theory on rotating thermals in previous editions.

I am not one of the heavyweights that Garry Speight thinks will come out in support of his theories on rotating thermals, but I have a view that may help Kingsley Just focus on the relevance of his arguments to what is happening when flying in a rotating thermal.

Starting with Kingsley's assumptions of constant angle of bank and airspeed, let us also assume the glider is at an ideal distance from the centre of our theoretical thermal and flying into the rotating air.

My view is that the gliders speed around the thermal is its airspeed minus the rotating air speed at its position in the thermal.

To test this view let us increase the thermal rotational speed. In order to remain at the ideal distance we previously had we would have to reduce the angle of bank. Increase it further until the headwind from the thermal equals the glider airspeed and we would not be banked at all. Notice that I have not mentioned groundspeed? Over to the heavy-weights!

Thank you for your articles Garry.